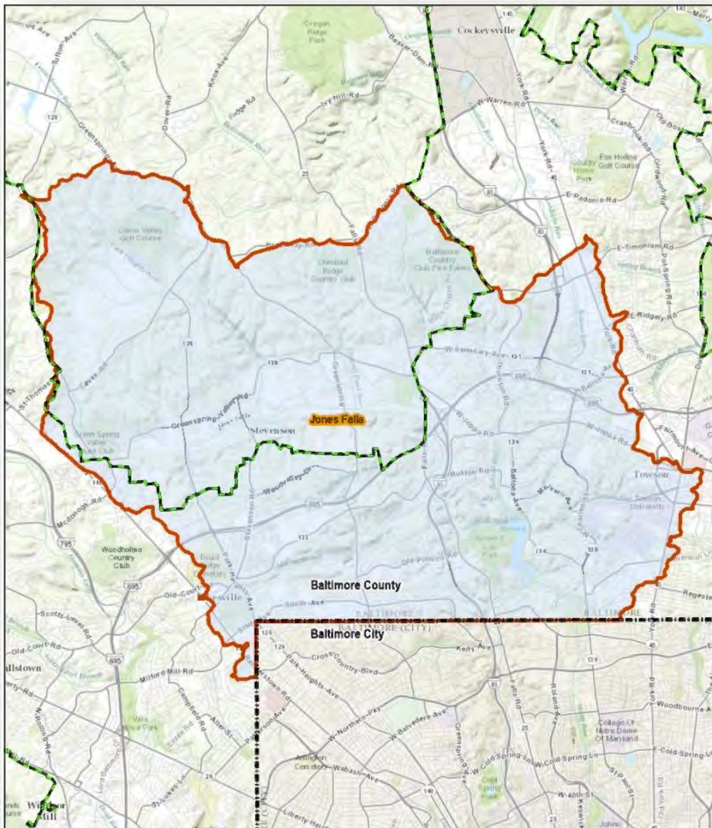
BALTIMORE COUNTY
TMDL IMPLEMENTATION PLAN

Bacteria in Jones Falls



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December 2016

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List of Abbreviations

ARA **Antibiotic Resistance Analysis**

BMP	**Best Management Practice**
BOD	**Biological Oxygen Demand**
BSID	**Biological Stressor Identification**
BST	**Bacteria Source Tracking**
CBP	**Chesapeake Bay Program**
CFR	**Code of Federal Regulations**
Chl a	**Chlorophyll a**
COMAR	**Code of Maryland Regulations**
CWA	**Clean Water Act**
DO	**Dissolved Oxygen**
DPW	**Department of Public Works**
ED	**Extended Detention**
EOF	**Edge of Field**
EOS	**Edge of Stream**
EPA	**U.S. Environmental Protection Agency**
EPS	**Environmental Protection & Sustainability**
FSA	**Farm Service Administration**
HSG	**Hydrologic Soil Groups**
HUC	**Hydrologic Unit Code**
IP	**Implementation Plan**
LA	**Load Allocation**
lbs/yr	**Pounds per Year**
MAST	**Maryland Assessment Scenario Tool**
MD	**Maryland**
MDA	**Maryland Department of Agriculture**
MDE	**Maryland Department of Environment**
MDP	**Maryland Department of Planning**
µg/l	**Micrograms per Liter**
mg/l	**Milligrams per Liter**
MGD	**Million Gallons per Day**
MGS	**Maryland Geological Survey**
MOS	**Margin of Safety**
MPN	**Most Probable Number**

MPR	**Maximum Practicable Reduction**
MS4	**Municipal Separate Storm Sewer System**
NLCD	**National Land Cover Dataset**
NMP	**Nutrient Management Plan**
NOAA	**National Oceanic and Atmospheric Administration**
NPDES	**National Pollutant Discharge Elimination System**
NPS	**Nonpoint Source**
NSA	**Neighborhood Source Assessment**
OIT	**Office of Information Technology**
PAA	**Pervious Area Assessment**
PAI	**Office of Permits Approvals & Inspections**
POM	**Particulate Organic Matter**
PS	**Point Source**
RTG	**Reservoir Technical Group**
SCWQP	**Soil Conservation and Water Quality Plan**
SSA	**Science Services Administration**
SSO	**Sanitary Sewer Overflow**
SWAP	**Small Watershed Action Plan**
SWM	**Stormwater Management**
TMDL	**Total Maximum Daily Load**
TN	**Total Nitrogen**
TP	**Total Phosphorus**
TSI	**Trophic State Index**
TSS	**Total Suspended Solids**
URDL	**Urban Rural Demarcation Line**
USGS	**United States Geological Survey**
USLE	**Urban Soil Loss Equation**
WAG	**Watershed Advisory Group**
WIP	**Watershed Implementation Plan**
WLA	**Waste Load Allocation**
WQBEL	**Water Quality Based Effluent Limitations**
WQIA	**Water Quality Improvement Act**
WQLS	**Water Quality Limited Segment**

WQMP	**Water Quality Management Plan**
WRAS	**Watershed Restoration Action Strategy**
WWTP	**Waste Water Treatment Plant**

This Implementation Plan (IP) has been prepared to address the bacteria problem in the Jones Falls that has the potential to negatively affect human health and the recreational use of the streams in the watershed. The amount of bacteria that needs to be reduced has been determined by a Total Maximum Daily Load (TMDL) developed by Maryland Department of the Environment and, after a public comment period, submitted to US Environmental Protection Agency (EPA) – Region 3 for review and approval. EPA approved the TMDL in 2008. Final TMDL documents can be found at MDE's website under Current Status of TMDL Development in Maryland. See the document is entitled Total Maximum Daily Loads of Fecal Bactria for the Non-Tidal Jones Falls Basin in Baltimore City and Baltimore County, Maryland.

1.1 What is a TMDL

A TMDL has two different meanings. It is the document that is produced by MDE when any Maryland waterbody is listed on the state's 303(d) list of impaired and threatened waters. MDE must then submit the TMDL to EPA for approval. Any time a TMDL document is developed, extensive scientific study is done on the pollutant of concern in the listed waterbody. This study is done with the goal of finding the maximum load of the pollutant that the waterbody can receive and still meet Maryland's water quality standards. It is often thought of as a "pollution diet" for the watershed. All of the studying and monitoring that is done in preparing the TMDL document boils down to a single maximum load number that will be the target for pollution reduction in the waterbody. This number is also called a TMDL. In other words, the goal of the TMDL document is to justify the TMDL number, which can be found within the TMDL document.

The TMDL number is expressed as a sum of all the different sources of the pollutant plus a Margin of Safety (MOS). The MOS values help to account for any lack of knowledge or understanding concerning the relationship between loads and water quality and also for any rounding errors in the TMDL calculation (calculation format shown below). Expressing the TMDL in terms of this simple equation makes it easier to see where pollution reduction efforts need to be focused. In other words, which sources can be reduced to reach the final TMDL number, by how much they need to be reduced, and which pollution sources are not practical for reduction. The sources that make up the final TMDL number are categorized as either Load Allocation (LA) or Waste Load Allocation (WLA). LAs are all nonpoint source loads, meaning that they do not come from a single source or pipe. LAs include agricultural runoff, forest runoff, and upstream loads. WLAs are all point source loads, meaning that they do come from a single traceable source. WLAs are further categorized as process water or stormwater. Process water WLA comes from sources that have permits allowing them to release a specific amount of a pollutant into the water. They include individual industrial facilities, individual municipal facilities, and mineral mining facilities. Stormwater WLA is any stormwater that is regulated by a municipal separate storm sewer systems permit (MS4), water from industrial facilities permitted to release stormwater, and all runoff from construction sites. All Baltimore County urban stormwater is regulated under Baltimore County's MS4 permit. That means that stormwater WLA includes all of the water that runs to any storm drain within the watershed area. The MOS is the final part of the equation. The MOS can be implicit, meaning that the final TMDL was calculated in such a way that it accounted for any errors without needing to tack an explicit MOS to the end of the sum of load sources equation. When an explicit MOS is necessary, it is assumed that a 5% reduction of the final TMDL number will be sufficient.

TMDL Sum of Load Sources Equation:

$$\text{TMDL} = \text{LA} + \text{WLA Stormwater} + \text{WLA Process Water} + \text{MOS}$$

1.1.1 How is the Final TMDL Determined

The process of determining the TMDL number can be very complex. Pollution data are regularly collected throughout Maryland by many different federal, state, and local government agencies as well as universities and watershed organizations. The agency or organization may send individuals out to the stream to collect and measure information about the watershed as part of a study or regular monitoring program. Data are also collected from the many different monitoring stations that are located throughout Maryland's watersheds. Some of these monitoring stations have been collecting water data for tens of years. The U.S. Geological Survey and the Maryland Department of Natural Resources monitoring stations are often used as the data source for Maryland TMDLs. To find out who is keeping an eye on your watershed see MDE's Water Quality Monitoring Web Page.

Complex scientific models are often used to help find a practical number for the total reduction. Models often use existing monitoring data and observations about the watershed area in a calculation that determines the TMDL number. The type of model used and the complexity of the model varies by pollutant, waterbody type, and complexity of flow conditions. The specific model used for this TMDL is explained in Section 3.

In all cases, scientists first find a baseline load for the pollutant. The baseline load is how much of the pollutant is in the waterbody at the time of the study, before restoration actions specifically developed to reach the TMDL number are implemented. The calculated target number, that is the TMDL, is the final goal. It could be thought of as the finish line in the TMDL process. That is not to say that other restoration efforts will not continue once that target is reached, but that the waterbody will be able to meet state water quality standards and can be removed from the list of impaired and threatened waters for that particular pollutant .

When calculating the TMDL number, a percent reduction and load reduction are usually calculated as well. The load reduction is the difference between the baseline load and the TMDL target. Think of it as the amount that needs to be removed from the system in order to reach the target. The percent reduction is the percentage of the baseline load that needs to be removed in order to reach the TMDL target.

1.2 Geographic Area

Pollution reduction goals are determined by watershed. A watershed is all the land area where all of the water that runs off that land and all the water running under that land drain into the same place. Everything within a watershed is linked by a common water destination. Watersheds exist at many levels: some very large, and some quite small. Identifying your watershed is similar to identifying your current location on a map. You could say you are in the United States, or that you are in Maryland, or that you are in your kitchen at your specific street address. Similarly, you could say that you are in the Mid-Atlantic Region Watershed, which drains to the Atlantic Ocean, Long Island Sound and Riviere Richelieu, a tributary of the St. Lawrence River. You could also say that you are in the Upper Chesapeake Bay Watershed, which includes the area of drainage to the Chesapeake Bay that is north of the Maryland-Virginia line. Both would describe a watershed that you are located in. However, watersheds can become much more specific.

A system was established by the U.S. Geologic Survey for dividing the U.S. into successively smaller hydrologic units. Each hydrologic unit is identified by a Hydrologic Unit Code (HUC), which range from two to twelve digits. The smaller the scale of the watershed, the more digits it has in its code. For example, the Mid-Atlantic Region is a 2-digit watershed and the Upper Chesapeake Bay is a 4-digit watershed. The 6-digit unit, also known as the "basins" unit, is to serve as the common scale for watershed assessments at the national level, but the condition of these basins can be determined based on an aggregation of assessments of even smaller watershed units. Maryland has chosen to go the route of assessing smaller watershed units. As a result, TMDLs are determined at the 8-digit watershed scale. For a further explanation of HUCs or to see maps of watersheds at different HUC levels, go to: USGS Hydrologic Unit Maps. If you would like to know which Maryland 8-digit watershed you are located in, go to MDE's Find My Watershed Map.

It is important to note that 8-digit watersheds can overlap multiple counties and may, therefore, have several regulating authorities.

1.2.1 Jones Falls Geographic Area

The Jones Falls is an 8-digit (02-13-09-04) watershed that covers a total land area of 34,122 acres. The watershed originates in Baltimore County and flows through Baltimore City to the tidal waters of the Northwest Branch (Inner Harbor) of Baltimore Harbor. The Baltimore County portion of the watershed comprises 25,399 acres or 76% of the land area of the watershed (Figure 1.1).

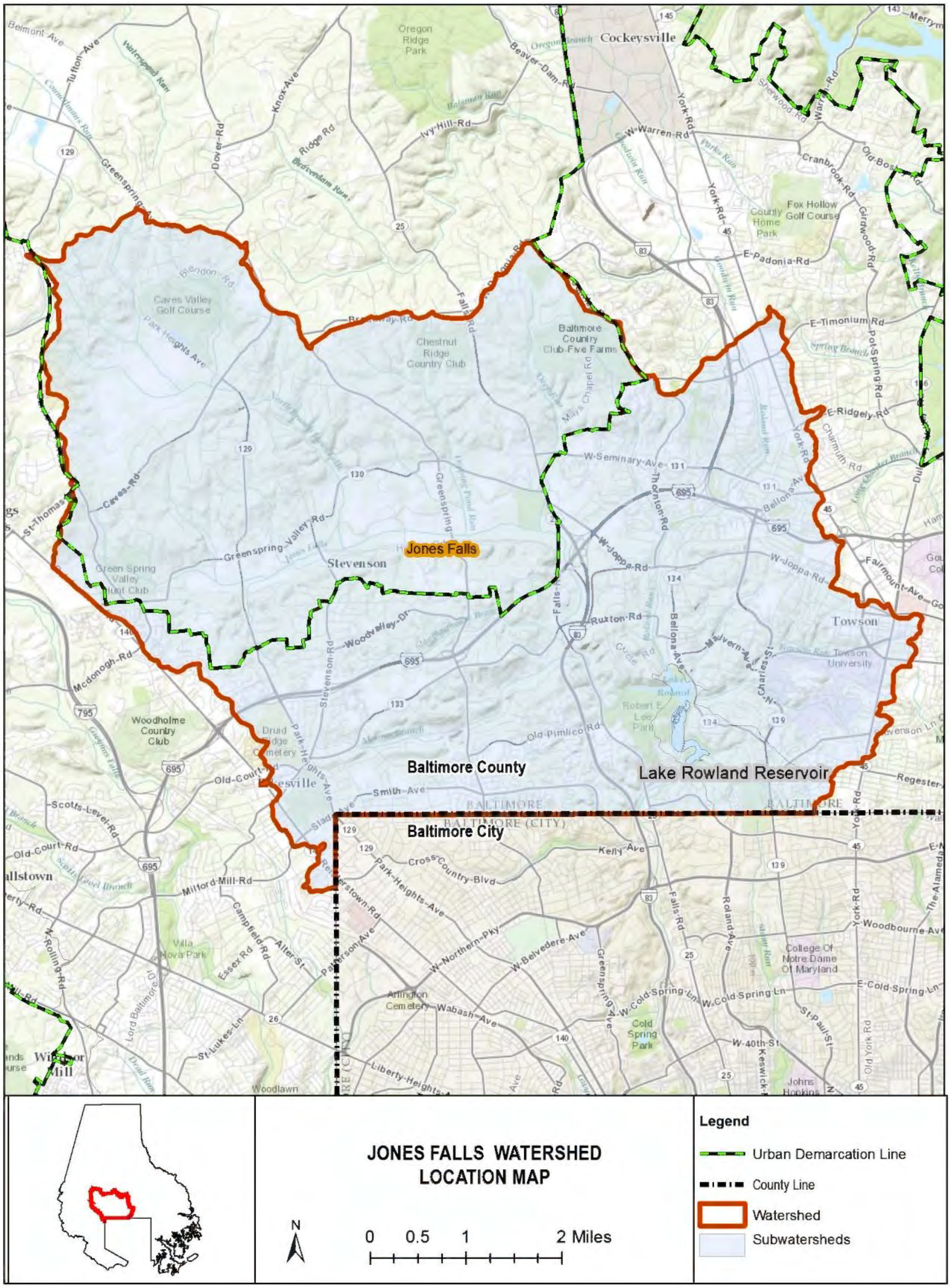

Figure 1.1: Jones Falls Watershed, Baltimore County Portion

1.3 Goal of the TMDL Implementation Actions

TMDL Implementation Plan Objective:

Through a cooperative effort of Baltimore County Department of Environmental Protection and Sustainability, other county agencies, local watershed associations, and the general public, to provide a comprehensive plan of action for achieving TMDL targets and ultimately restoring the health of Baltimore County waters to acceptable water quality standards.

Water quality standard for bacteria in the Jones Falls: geometric mean for *E. coli* of 126 MPN/100 ml.

1.4 Document Organization

The Baltimore County TMDL implementation plans provide the following information to explain the necessity of the TMDL Implementation Plan and to develop a management strategy that will be followed in order to meet county TMDL reduction targets. The County will take an adaptive management approach that will include periodic assessments to determine progress and identify changes needed in the management strategy to meet the reduction targets in a timely, cost effective manner.

Section 1 - Introduction

This Introduction states the pollutant that is being addressed by the TMDL IP, and the watershed for which the IP was developed. It provides a background on what a TMDL is and how the TMDL is determined. A general description of the geographic area for the specific IP is provided. The Introduction also states the overall goal of the TMDL IP and summarizes the actions that have been identified to bring Baltimore County to that goal. It also includes a brief summary of the contents of the thirteen sections of the TMDL Implementation Plan.

Section 2 - Regulatory Policy and Planning

This part of the document describes the administration and legal authority that mandates the development of Baltimore County's TMDL implementation plan and oversees its fulfillment. It will provide a background of how various regulating authorities and policies are related to the requirement to develop a TMDL Implementation Plan. It will also summarize the various planning guidance documents that have been produced to assist in the development of TMDL Implementation Plans and how TMDL Implementation Plans fit in the overall Baltimore County planning context.

Section 3 - TMDL Summary

The section summarizes the original TMDL document that was submitted by MDE and approved by the EPA. The summary includes: when the TMDL was developed, what is impaired, why the TMDL was developed, a description of the analysis process that was used to determine the total maximum daily load targets, the baseline year of data collection and analysis, the results from that analysis, and a further break down of the target loads by source sector.

Section 4 - Literature Summary

Each TMDL IP will address a specific pollutant. This part of the document provides an overview of the pollutant that is summarized from published literature. The literature summary includes known sources of the pollutant, the impacts associated with the pollutant, the pathways and transformations of the pollutant, and other relevant ecological processes that affect how the pollutant can be controlled and regulated.

Section 5 - Watershed Characterization

Characterization of the watershed will include geographical and technical information for the portion of the watershed that is specific to each TMDL IP. Each characterization will describe the watershed acreage, population size, geology and soils, topography, land use, streams, infrastructure related to watershed pollution sources, implemented restoration projects since the baseline year, and changes in pollutant load since the baseline year.

Section 6 – Existing Data Summary

This section will include a summary of Baltimore County's existing monitoring data that will be pertinent to the pollutant in question. It may also include some data received from sources other than Baltimore County, such as data from the Maryland Department of the Environment, or other relevant sources.

Section 7 - Summary of Existing Restoration Plans

Previous planning efforts will be summarized in this section. Water Quality Management Plans (WQMP) and Small Watershed Action Plans (SWAP) applicable to the IP area are identified. The process and goals for SWAP development are explained.

Section 8 - Best Management Practice Efficiencies

This section is an explanation of the best management practices that will be used for removing the particular pollutant and the known efficiency of those best management practices. A table will be found in this section of BMPs and the known reduction efficiency for the pollutants that can be reduced by each BMP. BMP efficiencies will also include a discussion of the uncertainty and research needs for BMPs.

Section 9 - Implementation

The implementation section will provide a description of programmatic, management, and restoration actions; and pollutant load reduction calculations to meet the pollutant reduction target for the specific pollutant. For each of the programmatic, management, and restoration actions there will be a list of responsible parties, actions, timeframe of actions, and performance standards.

Section 10 - Assessment of Implementation Progress

Assessment of implementation progress will give Baltimore County a formal method of reporting on the development of implementation and of describing the progressive success of implementation actions. The section will include a description of tracking and reporting mechanisms, and a monitoring plan that includes progress monitoring as well as BMP effectiveness monitoring.

Section 11 - Continuing Public Outreach Plan

This part of the document will be a continuing public outreach plan. It will encourage public involvement in the implementation process, extending beyond the finalization of this document.

Section 12 - References

A list of references used in the creation of this document will be provided.

Section 2 - Legal Authority, Policy, and Planning Framework

The Legal Authority, Policy, and Planning Framework section will present, in brief, the background on the legal requirements that pertain to the development of Total Maximum Daily Loads (TMDLs), and the preparation of TMDL Implementation Plans. This section will also cover the planning framework for the development of the TMDL Implementation Plans (IP). Furthermore, this section is intended to provide the context for the development of this TMDL Implementation Plan and understanding of the linkage between water quality and the TMDL. Whether at the federal or state level there are a number of processes at work that result in the regulations that must be followed to remain within the law. First, legislation is passed by an elected governing body (e.g. Congress, state legislature), and once passed and signed by the executive branch, they become Acts (laws), such as the Clean Water Act. In order to provide guidelines in maintaining compliance with these laws, it is often necessary that regulations be issued to specify the law's requirements. A regulation is a rule issued by a government agency that provides details on how legislation will be implemented, and may set specific minimum requirements for the public to meet if they are to be considered in compliance with the law. These regulations may come in various forms, such as the Code of Federal Regulations (CFR), or Code of Maryland Regulations (COMAR). The information that follows is generally taken from CFR and COMAR.

Under the CFR, Title 40 encompasses the regulations enforced by the U.S. Environmental Protection Agency (EPA). These regulations include not only those related to water quality, but also air quality, noise, and a variety of land based regulations (oil operations, etc.)

2.1 Regulatory and Policy Framework

The ultimate regulatory authority for protecting and restoring water quality rests with the federal government through legislative passage of the Clean Water Act in 1972 and subsequent amendments. Prior to the Clean Water Act (1972), the Federal Water Pollution Control Act (1948) served as the basis for controlling water pollution. The Clean Water Act significantly amended the Federal Water Pollution Control Act and established the basic structure for regulating discharges of pollutants into the waters of the United States. Major amendments were enacted in 1977 and 1987 that further strengthened and expanded the Clean Water Act of 1972. The 1987 amendments incorporated the requirement that stormwater discharges from urban (municipal) areas be required to obtain a permit for discharge and that stormwater discharges from industrial sources also be permitted. There have been a number of minor amendments and reauthorizations over the years that have resulted in the law as it now stands.

There are several significant provisions of the Clean Water Act that pertain to TMDLs. These provisions include the requirement that states adopt Water Quality Standards by designating waterbody uses and set criteria that protect those uses. The Clean Water Act also requires states to assess their waters and provide a list (known as the 303(d) list) of waters that are impaired. The list specifies the impairing substance and requires that a TMDL be developed to address the impairment.

Through policy (memos dated November 22, 2002 and November 12, 2010) the EPA has indicated that the pollutant loads attributable to regulated stormwater discharges are to be included in the Waste Load Allocation as a point source discharge and not as part of the non-point load. The initial memo also affirmed that the Water Quality-Based Effluent Limitations (WQBELs) in Municipal Separate Storm Sewer System (MS4) permits may be expressed in the form of Best Management Practices (BMPs) and not as numeric limits for stormwater discharges. The second memo clarified that when the MS4 permits are expressed in the form of BMPs, the permit should contain objectives and measurable elements (e.g., schedule for BMP installation or level of BMP performance). By providing both an expected level of BMP performance and a schedule of implementation of the various practices, Baltimore County will have addressed this requirement. This plan once approved by Maryland Department of the Environment (MDE) will be enforceable under the terms of the permit.

2.2 Maryland Use Designations and Water Quality Standards

In conformance with the Clean Water Act, the State of Maryland has developed use designations for all of the waters in Maryland, along with water quality standards to maintain the use designations.

Designated uses define an intended human and aquatic life goal for a waterbody. It takes into account what is considered the attainable use for the waterbody, for protection of aquatic communities and wildlife, use as a public water supply, and human uses, such as recreation, agriculture, industry, and navigation. Water quality standards include both the Use Designation and Water Quality Criteria (numeric standards). Water Quality Criteria are developed to protect the uses of a waterbody.

2.2.1 Use Class Designations

Every stream, lake, reservoir, and tidal waterbody in Maryland has been assigned a Use Designation. The Use Designation is linked to specific water quality standards that will enable the Designated Use of the waterbody to be met. A listing of the Use Designations follows:

- Use I: Water contact recreation, and protection of nontidal warm water aquatic life.
- Use II: Support of estuarine and marine aquatic life and shellfish harvesting (not all subcategories apply to each tidal water segment)
    - Shellfish harvesting subcategory
    - Seasonal migratory fish spawning and nursery subcategory (Chesapeake Bay only)
    - Seasonal shallow-water submerged aquatic vegetation subcategory (Chesapeake Bay only)
    - Open-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-channel refuge use (Chesapeake Bay only)
- Use III: Nontidal cold water – usually considered natural trout waters
- Use IV: Recreational trout waters – waters stocked with trout

The letter "P" may follow any of the Use Designations, if the surface waters are used for public water supply. There may be a mix of Use Classes within a single 8-digit watershed; for example, Gwynns Falls has Use I, Use III, and Use IV Designations depending on the subwatershed.

Table 2.1: Designated Uses and Applicable Use Classes

Designated Uses	Use Classes							
	I	I-P	II	II-P	III	III-P	IV	IV-P

Growth and propagation of fish (not trout), other aquatic life and wildlife	✓	✓	✓	✓	✓	✓	✓	✓
Water contact sports	✓	✓	✓	✓	✓	✓	✓	✓
Leisure activities involving direct contact with surface water	✓	✓	✓	✓	✓	✓	✓	✓
Fishing	✓	✓	✓	✓	✓	✓	✓	✓
Agricultural water supply	✓	✓	✓	✓	✓	✓	✓	✓
Industrial water supply	✓	✓	✓	✓	✓	✓	✓	✓
Propagation and harvesting of shellfish			✓	✓				
Seasonal migratory fish spawning and nursery use			✓	✓				
Seasonal shallow-water submerged aquatic vegetation use			✓	✓				
Seasonal deep-water fish and shellfish use			✓	✓				
Seasonal deep-channel refuge use			✓	✓				
Growth and propagation of trout					✓	✓		
Capable of supporting adult trout for a put and take fishery							✓	✓
Public water supply		✓		✓		✓		✓

2.2.2 Water Quality Criteria

Water quality criteria are developed to protect the uses designated for each waterbody. Certain standards apply over all uses, while some standards are specific to a particular use. The criteria are based on scientific data that indicate threats to aquatic life or human health. For the protection of aquatic communities the criteria have been developed for fresh water, estuarine water, and salt water. The criteria have been further based on acute levels (have an immediate negative effect) and chronic levels (have longer term effects). The human health criteria are based on drinking water levels, organism consumption levels, or a combination of drinking water and organism consumption levels, or recreational contact bacteria levels.

Dissolved oxygen criteria for all Use Designations is 5 mg/L, except for Use II Designations and special criteria for drinking water reservoir hypolimnion waters (bottom waters of the reservoir).

Bacteria criteria are based on human health concerns, and apply to all Uses, with additional bacteria criteria applicable in shellfish waters. Since none of the local TMDLs are related to the shellfish criteria, they are not discussed here. The human health criteria are based on either the geometric mean of 5 samples or single sample criteria based on the frequency of full body contact, these criteria are displayed in Table 2.2. For the freshwater bacteria TMDLs the indicator bacteria *E. coli* has been used in the development of the TMDL, therefore it serves as the water quality end point. The human health recreational contact bacteria criteria are displayed in Table 2.2. The table displays both the geometric mean for bacteria and single sample maximum allowable bacteria concentrations based on the frequency of full body contact.

Table 2.2: Bacteria Criteria for Human Health (MPN/100 ml)

Indicator	Steady State Geometric Mean Density	Single Sample Maximum Allowable Density			
		Frequent Full Body Contact Recreation	Moderately Frequent Full Body Contact Recreation	Occasional Full Body Contact Recreation	Infrequent Full Body Contact Recreation
Freshwater (Either Apply)					
Enterococci	33	61	78	107	151
E. coli	126	235	298	410	576
Marine					
Enterococci	35	104	158	275	500

2.3 Planning Guidance

In March of 2008 the EPA released a guidance document on the development of watershed plans entitled *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*. The handbook laid out nine minimum elements to be included in watershed plans, commonly called the "a through i" criteria. The criteria include:

a. An identification of the causes and sources or groups of sources that will need to be controlled to achieve the load reductions estimated in the watershed plan.

b. Estimates of pollutant load reductions expected through implementation of proposed Nonpoint Source (NPS) management measures.

c. A description of the NPS management measures that will need to be implemented.

d. An estimate of the amounts of technical and financial assistance needed to implement the plan.

e. An information/education component that will be used to enhance public understanding and encourage participation.

f. A schedule for implementing the NPS management measures.

g. A description of interim, measurable milestones for the NPS management measures.

h. A set of criteria to determine load reductions and track substantial progress towards attaining water quality standards.

i. A monitoring component to evaluate effectiveness of the implementation efforts over time.

EPA now evaluates watershed plans on the basis of the above criteria in consideration of its grant funding. The State of Maryland is also increasingly using the above criteria for funding consideration. Baltimore County has used these criteria since the publication of the handbook in the development of its Small Watershed Action Plans; and will use the criteria in the development of this TMDL Implementation Plan.

MDE developed a guidance document in conjunction with local government representatives entitled *Maryland's 2006 TMDL Implementation Guidance for Local Governments*, which provides a framework for the development of TMDL Implementation Plans. MDE has also provided guidance on the development of TMDL Implementation Plans related to specific pollutants. Guidance for specific pollutants includes:

- PCBs
- Bacteria
- Mercury
- Trash

These guidance documents have been taken into consideration in the development of the Baltimore County TMDL Implementation Plans.

2.4 Water Quality Standards Related to This Implementation Plan

The Jones Falls (02-13-09-04) watershed has a Use I and Use III Designation in Baltimore County. Use I includes water contact recreation and protection of warm water fisheries, while Use III includes water contact recreation and cold water fisheries. The water quality criteria applicable to the bacteria TMDL are those related to bacteria, specifically, the *E. coli* criteria above in Table 2.2. The bacteria criteria are designed to protect humans from health issues that may arise from water contact recreation.

The ultimate water quality endpoint, as indicated by MDE, is the attainment of an *E. coli* geometric mean concentration of 126 MPN for dry weather conditions and during all seasons. Since the majority of human recreation water contact occurs during dry weather and in the warm seasons, the 126 MPN criteria target will be applied to those conditions. In addition, Baltimore County will use the frequency of full body contact criteria for single samples as measures of progress. Streams, unlike swimming beaches will not have frequent full body contact, but much more limited contact. The targets for interim periods are displayed in Table 2.3.

Table 2.3: Five-Year Interim Targets for Single Sample and Geometric Mean Bacteria Densities

Single Sample Target (MPN/100 ml) – All Stations				
Weather Condition	**2020**	**2025**	**2030**	**2035**
Dry/Low Flow	576	410	298	235
JON-3 (JON0184) Geometric Mean Target (MPN/100 ml)				
Low Flow – Annual	222	190	158	126
Low Flow - Seasonal	407	314	220	126
JON-4 (UQQ0005) Geometric Mean Target (MPN/100 ml)				
Low Flow – Annual	300	242	184	126
Low Flow - Seasonal	686	499	313	126
JON-2 (JON082) Geometric Mean Target (MPN/100 ml)				
Low Flow – Annual	NA*	NA*	NA*	126
Low Flow - Seasonal	136	133	129	126

The TMDL summary provides context for the TMDL implementation plan. It is necessary to understand some basic information from the original TMDL document that preceded this particular implementation plan. The TMDL document describes the condition of the watershed at the time that the baseline load of the pollutant was calculated. The baseline load is simply a measurement of the amount of the pollutant that was in the waterbody during a specific time. The baseline load provides a starting pollutant measurement for the county to reduce from, in order to meet the TMDL target. The term TMDL is also used to describe the specific numeric load target, which is explained in detail within the TMDL document. The original TMDL document provides a detailed justification for choosing the TMDL target number. This justification is a description of the entire technical process including monitoring methods and calculations. The following section is a simplification of that section of the TMDL document and a brief explanation of why the TMDL was developed for the specific pollutant in this watershed.

3.1 TMDL Background

- **The Problem:** The TMDL was developed because the steady state geometric mean of *E.coli* in the Jones Falls watershed was found to be above the state water quality standard of 126MPN/ 100ml for freshwater.

The Jones Falls watershed was listed as being impaired by bacteria in 2002. MDE developed the TMDL and submitted it to EPA in 2006. It was approved by EPA in 2008.

The requirements for listing a watershed as category 5 for fecal bacteria, also known as the 303(d) list, are as follows for all uses:

- A steady state geometric mean must be calculated with data from the past two to five years
- The data must be from samples that were collected during the beach season in dry, steady state conditions
- The resulting steady state geometric mean is greater than 35 cfu/100 ml enterococci in marine/estuarine waters, 33 cfu/100 ml enterococci in freshwater, or 126 cfu/100 ml *E. coli* in freshwater

The geometric mean target for freshwater equates to an approximate risk of 8 illnesses per 1,000 swimmers at freshwater beaches. This means that for every thousand people that swim in the waterbody, approximately 8 people will get sick. This is only an approximation, as every individual person has a different susceptibility to disease and illness.

The TMDL analysis specifically looked at *E.coli* as the indicator of water impairment. Bacteria data was collected at Department of Natural Resources CORE monitoring stations to identify impairment. Additional monitoring was conducted at five stations throughout Jones Falls from October 2002 to June 2003. Bacteria counts were highly variable and ranged from 10 to 10,000 MPN/ 100ml. Any bacteria counts greater that 126 MPN/100ml indicates an approximate risk of illness greater than 8 per 1,000 swimmers.

The baseline year is 2003 based on the final year of bacteria monitoring used to develop the Jones Falls bacteria TMDL.

3.2 TMDL Development

The first step in the process of developing the annual average TMDLs was to find base line condition loads for each of five bacteria monitoring stations that were located in the Jones Falls watershed. The challenge was that the rate of water flow for and river and stream naturally fluctuates very regularly and it is important for baseline loads to be calculated for the average flow rate. Rates of flow were classified as high flow or mid/low flow. These classifications were called the flow strata. First, annual average geometric means were calculated for each sub-watershed's flow strata (high flow and mid/ low flow). A flow analysis of several watersheds throughout Maryland found that flows between the 20th and 28th percentile represented average daily flows. Accordingly, for the purposes of this analysis, flows above the 25th percentile were designated as high flow and flows below the 25th percentile were designated as mid/low flows. The flow levels and the steady state geometric mean data were used to calculate an annual weighted geometric mean for each of the five stations that is unbiased by flow strata.

The data was used to calculate a bias correction factor, which would ultimately be used to calculate a base line load for each station. The bias correction factor is simply a calculated number that is used in the final base line load calculation to ensure that the base line load is representative of the natural duration of high flow and mid/low flow conditions.

Federal regulations require that TMDLs take critical condition into account, meaning the condition when the waterbody is most vulnerable. For this TMDL, the critical condition was accounted for by assessing the time period when water contact recreation is expected, i.e., seasonal conditions from May 1st through Sept 30th. Accordingly, steady state and weighted geometric means were also calculated for the seasonal bacterial load. Calculating seasonal conditions is also helpful because water quality standards are measured under these conditions. The calculation for the seasonal condition was necessary for estimating reductions needed to meet water quality standards.

Bacteria source tracking (BST) was used to identify relative contributions of different bacteria sources at the four stations in the Jones falls watershed. Samples were collected once per month for one year. Samples that have known fecal sources are collected from the watershed. A technique known as antibiotic resistance analysis (ARA) is used to identify patterns of antibiotic resistance displayed in the known samples. The antibiotic resistance patterns can then be compared to patterns in water samples containing bacteria of unknown origin. The BST can identify probable sources of bacteria by matching the antibiotic resistance patterns of known bacteria origins to the unknown samples. In order to accurately represent the expected contribution of each source at each station, a stratified weighted mean of the samples was calculated. The stratified weighted mean accounted for the proportion of high to mid/low flow volume. Table 3.1 displays the results for the annual monitoring data by flow stratum and the weighted percent contribution from the various sources. Fecal bacteria source loads were also calculated at each station for the seasonal period. These results are presented in Table 3.2.

Table 3.1: Distribution of Bacteria by Source (%) – Annual Data

Station	Flow Stratum	% Pets	% Human	% Livestock	% Wildlife	% Unknown
UQQ0005 (County)	High	16	40	14	7	23
	Low	14	67	4	4	12
	Weighted	14	60	6	5	15
SRU005 (City	High	9	74	3	1	13
	Low	11	57	4	1	27
	Weighted	10	61	4	1	23
JON0184 (County)	High	16	44	17	9	14
	Low	26	46	13	2	12
	Weighted	24	45	14	4	13
JON0082 (County)	High	9	56	13	3	20
	Low	23	44	10	4	19
	Weighted	19	48	11	4	19
JON0039 (City)	High	20	62	2	1	15
	Low	17	58	10	4	11
	Weighted	17	59	8	3	12

Table 3.2: Distribution of Bacteria by Source (%) – Seasonal Data (May 1st through September 30th)

Station	Flow Stratum	% Pets	% Human	% Livestock	% Wildlife	% Unknown
UQQ0005 (County)	High	17	45	14	6	17
	Low	14	66	4	4	13
	Weighted	15	61	7	4	14
SRU005 (City	High	15	73	6	0	6
	Low	10	67	8	1	14
	Weighted	11	68	7	1	12
JON0184 (County)	High	19	53	15	8	4
	Low	28	45	11	1	14
	Weighted	26	47	13	3	11
JON0082 (County)	High	13	66	7	2	11
	Low	20	52	11	2	13
	Weighted	18	56	10	2	13
JON0039 (City)	High	23	55	3	0	18
	Low	21	51	12	4	12
	Weighted	22	52	10	3	13

The majority of bacteria in the Jones Falls was from human sources at all monitoring stations. It was assumed that human sources would have the highest risk of causing gastrointestinal illness, so those sources were targeted for the highest reductions. Maximum practicable reduction (MPR) targets were determined, based on available literature and best professional judgment, for each bacteria source by sub-watershed. The sub-watersheds are the stream segments in between the monitoring stations within the Jones Falls. Any area where a waste water treatment plant is located upstream to a watershed segment, human bacteria levels for that segment were considered to be at the MPR because the loads have already been permitted. In the case of bacteria sources from domestic animal waste, the MPR was based on the success of education and public outreach. Wild life sources were given a 0% MPR because there are no programmatic approaches to reduce wildlife waste in order to meet water quality standards. The MPRs were, thus, assigned the following values: 95% Human sources, 75% Domestic sources, 75% Livestock sources, and 0% Wildlife sources.

In the MPR scenario, none of the five monitored segments were able to meet water quality standards using the values listed above. This means that there is no practicable solution. In this case, another scenario was applied where the allowable reduction for each of the five source categories was increased to 98%. The results indicate that the Jones Falls watershed can only meet water quality standards in a scenario where reductions exceed the maximum practicable reduction.

3.3 TMDL Results

Part of the development of the bacteria TMDL is to calculate a baseline load as the starting point. For the Gwynns Falls watershed the baseline load was calculated based on monitoring data for each of the four monitoring points, with the load calculated for both high low and low from conditions. Table 3.3 presents the results.

Table 3.3: Gwynns Falls – Annual Steady-State Geometric Means by Station and Flow Condition

Monitoring Station	Flow	N	Annual Steady-State Geometric Mean (MPN/100 ml)	Annual Overall Geometric Mean (MPN/100 ml)
JON0184 (County)	High	6	532	306
	Low	18	254	
UQQ0005 (County)	High	6	593	406
	Low	18	358	
JON0082 (County)	High	6	619	141
	Low	18	86	
JON0039 (City)	High	9	2,679	712
	Low	15	485	
SRU0005 (City)	High	9	4,545	2,392
	Low	15	1,931	

The TMDL calculated the seasonal dry weather period (May 1st – September 30th) steady state geometric mean for each of the five stations. These results were used to calculate the reductions needed to meet the bacteria water quality standards, as this is the period and weather conditions when human contact with the water are most likely to occur. The results are presented in Table 3.4

Table 3.4: Seasonal (May 1st – September 30th) Dry Weather Steady-State Geometric Means by Station (MPN/100 ml)

Monitoring Station	Flow	N	Geometric Mean (MPN/100 ml)	Seasonal Overall Geometric Mean (MPN/100 ml)
JON0184 (County)	High	4	1,545	664
	Low	8	501	
UQQ0005 (County)	High	4	1,368	976
	Low	8	872	
JON0082 (County)	High	4	1,152	236
	Low	8	139	
JON0039 (City)	High	5	1,164	495
	Low	7	372	
SRU0005 (City)	High	5	9,105	3,343
	Low	7	2,394	

The TMDL is equal to the baseline load multiplied by one minus the required reduction. The required reduction is the percentage by which the baseline load will need to be reduced to meet water quality standards. It is also important to note that a reduction in concentration is proportional to a reduction in load (Table 3.5).

The TMDL is equal to the baseline load multiplied by one minus the required reduction. The required reduction is the percentage by which the baseline load will need to be reduced to meet water quality standards. It is also important to note that a reduction in concentration is proportional to a reduction in load.

$$TMDL = L_b\,(1-R) \qquad (3.1)$$

- L_b: Baseline load
- R: Reduction required from baseline to meet water quality standards

Table 3.5: Jones Falls watershed TMDL summary

Station	*E. coli* Baseline Load (Billion *E.coli* MPN/year)	Target Load Reduction (Billion E.coli MPN/year)	TMDL Load (Billion *E.coli* MPN/year)	% Required Reduction
JON0184	1,206,325	1,115,075	91,250	92.4%
UQQ0005	133,955	123,370	10,585	92.1%
JON0082sub	887,315	845,340	41,975	95.3%
JON0039sub	3,340,480	1,184,260	156,220	95.3%
SRU0005	636,560	622,960	13,870	97.8%
Total	**6,204,270**	**5,890,735**	**313,900**	**94.9%**

Jones ~~Falls Total TMD~~L

3.4 TMDL Reductions Targets by Source Sector

The Jones Falls TMDL for fecal bacteria is made up of the following components:

- LA : Load Allocation for nonpoint sources not transported or discharged by stormwater systems
- WLA : LNB Waste Load Allocations for point sources, including waste water treatment plants (WWTPs), NPDES regulated stormwater discharges (MS4 permitted stormwater), and combined sewer overflows (CSOs)
- MOS : Margin of Safety was accounted for in this TMDL by estimating the loading capacity of the streams on a more stringent water quality criteria. The 126MPN/100ml criteria for *E.coli* was reduced by 5% to 119.7MPN/100ml.

Table 3.6: Jones Falls TMDL summary by source category

(Billion MPN *E. coli*/year)					
TMDL =	**LA +**	**WWTP WLA +**	**MS4 WLA +**	**CSOs WLA +**	**MOS**
28,234,210	**6,570**	**18**	**236,491**	**0.0**	**Incorporated**

Potential source contributions for TMDL allocation categories were identified as follows:

Table 3.7: Jones falls Bacteria source sector by source category

Source Category	LA	MS4 WLA	WWTP WLA	CSO WLA
Human		X	X	
Domestic		X		
Livestock	X			
Wildlife	X	X		

This review pertains to direct and indirect effects of bacteria on fresh water rivers and streams, specifically those effects that are relevant to the Jones Falls. This is not intended to be an exhaustive review of primary literature, but rather a summary of the sources, pathways and biological effects of bacteria in non-tidal watersheds from literature available to Baltimore County Department of Environmental Protection and Sustainability.

When we talk about bacteria in the watershed, we are specifically referring to fecal bacteria. That includes human feces, pet feces, livestock feces, and fecal matter from wild animals. The land use of a region determines which type of fecal bacteria may be a concern. Human and pet fecal matter can be a concern in both urban and rural areas, but urban areas may contribute a higher concentration of these sources of waste. Livestock waste is primarily a concern in rural land use areas. Forested areas contribute waste from wild animals, but this is considered the natural or background condition of fecal bacteria input to the watershed.

There is a wide variety of microorganisms that can be found in fecal matter. Most microorganisms do not cause disease to humans and wildlife, but some can be hazardous (US Geological Survey 2007) (World Health Organization 2003) . These disease causing microorganisms are known as pathogens. There is no specified number of pathogen cells that will make an individual sick (US Geological Survey 2007). Every person has a different state of health and immune system, which determines how susceptible his or her body is to disease. For this reason, water quality standards for bacteria are based on approximate risk of illness per 1,000 swimmers. The water quality standard is discussed in detail in the TMDL summary section. There is no way to say exactly how much bacteria will make someone sick, but it is possible to approximate the risk from a large sample of people (Maryland Department of The Environment 2009). For more information on the risk of pathogens in recreational water use see the Center for Disease Control and Prevention website on recreational water: Oceans Lakes and Rivers.

Pathogenic microorganisms can cause gastrointestinal infection from accidental ingestion of polluted water. Certain pathogenic organisms from fecal sources can also cause infections of the upper respiratory tract, ears, eyes, nasal passages, and skin (World Health Organization 2003). Infections due to recreational water contact are generally mild; however, this makes them hard to detect and attribute to water exposure (World Health Organization 2003).

Because there are so many different types of pathogens that cause many different symptoms of illness, indicator organisms are used to estimate the overall risk of illness instead of testing the water for each individual pathogen. Index organisms are also measured instead of testing for pathogens because each variety of possible pathogens requires a unique test. Tests are costly and time consuming and, therefore, testing for individual pathogens is not practical for routine monitoring (US Geological Survey 2007).

Escherichia coli (E.coli) is an index organism that is used to approximate the presence of illness causing organisms in fresh water. *E. coli* are bacteria that normally inhabit the human gut. Most *E.coli* are harmless and are actually healthy for the human intestinal tract (Centers for Disease Control and Prevention 2012). However, some are pathogenic and cause illness, in most cases diarrhea. These diarrhea causing *E.coli* are the bacteria that are associated with contaminated water (Centers for Disease Control and Prevention 2012) (World Health Organization 2003). In the late 1970s and early 1980s the USEPA conducted a study determining that *E.coli* has the strongest relationships to gastrointestinal illness in freshwater swimmers when compared to other possible fecal bacteria indicators (US Geological Survey 2007). For more information on bacteria monitoring and source tracking, see MDE's Bacterial Water Quality Monitoring page.

Bacteria enters the water mainly through feces, which is traceable to its sources through a source identification test as discussed in the TMDL summary section. Bacteria comes from both point and nonpoint sources. Nonpoint sources of pollution are those sources that do not have one discharge point but occur as runoff flows into streams. Manure spreading, the grazing of livestock, pet and wildlife deposition, and failed septic systems all create sources of bacteria that are transported to waterways as a nonpoint source. Point sources of fecal waste enter the stream or river through a pipe.

Municipal Separate Storm Sewer Systems (MS4) are point sources of stormwater discharge. This category includes Baltimore County's storm drain system. Fecal bacteria enter the watershed through the storm sewer system when domestic and wildlife wastes are washed into the local water (Clary, et al. 2008). Pet waste should always be disposed of properly, as it can wash into storm drains even when not directly dumped in or left near drains. Pet waste left in yards or on sidewalks will eventually contaminate the nearest storm drain.

Human wastes can enter water ways as a point source through illicit connections of sanitary sewers to stormwater sewers, and sanitary sewer overflows (Clary, et al. 2008). Illicit connections occur when individuals, intentionally or unintentionally, connect their sanitary sewer pipes to the storm sewer pipe. The sanitary sewer is meant to transport fecal waste to a sewage treatment plant where the water can be treated before returning it to a river or stream. The storm sewer system is not filtered. It runs directly under roadways and land to rivers and streams. Illicit connections allow the fecal waste to flow, completely unfiltered, into streams and rivers introducing pathogens directly into the waterbody. The Baltimore County Department of Environmental Protection and Sustainability Watershed Management and Monitoring Program is responsible for testing for the presence of illicit connections in the county.

Sanitary Sewer Overflows (SSO) are another source of human fecal bacteria pollution. They occur when the sewage system reaches capacity and overflows. The untreated sewage from these systems can flow into and contaminate local waters (Clary, et al. 2008). The Baltimore County Public Works Bureau of Utilities is responsible for construction, repair and maintenance of the sanitary sewer and storm sewer systems.

Human waste can also enter the waterbody as a nonpoint source through failed septic systems and damaged sanitary sewer pipes. The drainage from these systems makes its way through the drainage field and eventually into local waters.

Livestock wastes enter waterways through runoff from farms as result of manure spreading and grazing livestock. Grazing cows contribute 47 L of manure daily to pastures (Walker, et al. 1990). The manure left from grazing animals, and all of its bacteria, are swept by rain water into the nearest waterbody or storm drain. Manure spreading contributes to water pollution in a similar way, but the manure is spread over the entire surface of a field. Certain best management practices can reduce the amount of runoff from these sites such as runoff control practices, and long term storage of waste, which allows some bacteria to die off and allows manure to be applied during appropriate weather conditions to reduce runoff (Walker, et al. 1990). For more information on agricultural BMPs see the Maryland Department of Agriculture's Watershed Implementation Plan strategies.

Section 5: Watershed Characterization

This section summarizes the characterization of the Jones Falls watershed. Section 5.1 describes the natural landscape and Section 5.2 describes the human modified landscape.

5.1 The Natural Landscape

5.1.1 Location

The Jones Falls watershed is located in the Patapsco River region of the Chesapeake Bay watershed in portions of Baltimore County and Baltimore City, Maryland. The Jones Falls watershed comprises approximately 25,933 acres within Baltimore County. The Jones Falls mainstem flows east and south from its headwaters in Garrison, Maryland to its discharge into the Inner Harbor in downtown Baltimore. Several tributaries drain to the Jones Falls including Moores Branch, Roland Run, Towson Run, Western Run, and Stony Run. An impoundment is located at Lake Roland, just north of the Baltimore County/City boundary. Figure 5.1 shows the location of the Jones Falls watershed.

This IP will discuss the characteristics of the portions of the Jones Falls watershed located within Baltimore County.

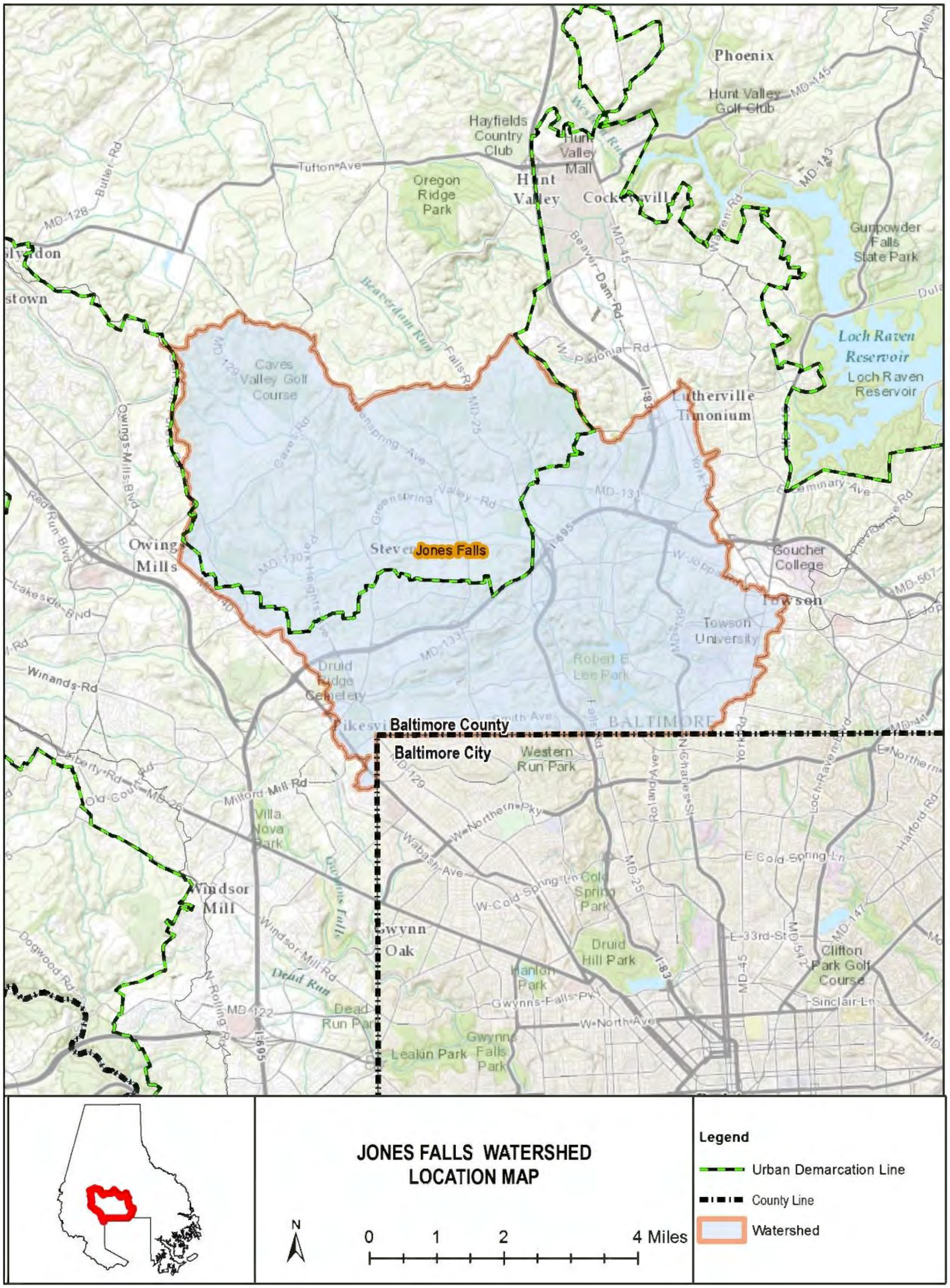

Figure 5.1: General Location Map of the Jones Falls Watershed

5.1.2 Geology/Soils

Geology

A majority (97%) of the Jones Falls watershed is located within the Piedmont physiographic province while 3% lies within the Coastal Plain physiographic province. The natural Piedmont landscape is characterized by rolling hills, thick soils on deeply weathered crystalline bedrock, and abundant forest litter that minimizes overland flow. The natural Coastal Plain is relatively flatter with soils formed from sedimentary deposits. The dominant geological formations in the Jones Falls watershed within Baltimore County are Loch Raven Schist (30%), Baltimore Gneiss (25%), and Cockeysville Marble (24%).

Soils

Soil type and moisture conditions greatly affect how land may be used and the potential for vegetation and habitat on the land. Soil conditions are also one determining factor for water quality and quantity in streams and rivers. Soils are an important factor to incorporate in targeting projects aimed at improving water quality or habitat. The type of soil has a major effect on runoff due to its infiltration rate (USDA-NRCS Unknown). Infiltration is the flow of water through the soil surface into the soil.

The Natural Resource Conservation Service classifies soils into four Hydrologic Soil Groups (HSGs) based on the soil's runoff potential. Runoff potential is the opposite of infiltration capacity; soils with high infiltration capacity will have low runoff potential, and vice versa. The four HSG's are A, B, C and D, where A's generally have the lowest runoff potential and D's have the greatest runoff potential. Dual hydrologic soil groups can be assigned as well. This happens when certain wet soils are placed in group D based solely on the presence of a water table within 24 inches of the surface even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained (USDA-NRCS 2009). When the rate of rainfall exceeds the infiltration rate, the excess water will start flowing over the soil surface and runoff begins (USDA-NRCS Unknown).

Runoff is the portion of precipitation that makes its way toward waterways as surface or subsurface flow. Runoff occurs after the evaporation, interception, infiltration and surface retention occur. The more runoff that occurs, the more likely nutrients, pollutants and pathogens are likely to enter waterways. Table 5.1 shows the percentage of each HSG in the Loch Raven Watershed within Baltimore County.

Table 5.1: Hydrologic Soil Group Data for the Jones Falls Watershed in Baltimore County

Hydrologic Soil Group (% of Baltimore County Portion of Watershed							
A	B	C	D	A/D	B/D	C/D	No Group
3.7	62.9	19.8	10.8	0.0	0.1	0.0	2.6

5.1.3 Stream Systems

Stream systems are a watershed's circulatory system, and the most visible attribute of the hydrological cycle. The stream system is an intrinsic part of the landscape, and closely reflects conditions on the land. Streams are a fundamental natural resource, with myriad benefits for plants, animals, and humans. Maintaining a healthy stream system is a priority for many individuals and organizations, and requires insuring that stream flows and water quality closely mimic the conditions found in un-impacted watersheds. Streams are the flowing surface waters, and are distinct from both groundwater and standing surface water (such as lakes), though they are connected with both of them.

The Jones Falls watershed contains approximately 154 miles of streams, all of which drain to the Baltimore Harbor, which is a part of the larger Chesapeake Bay watershed. A number of tributaries drain to the Jones Fall mainstem, including North Branch Jones Falls, Dipping Pond Run, Deep Run, Slaughterhouse Run, Moores Branch, Roland Run, Towson Run, Western Run, and Stony Run.

5.1.4 Livestock

Livestock refers to agriculture-related animals and are associated with pasture, feeding operations, and breeding and training facilities. In 2003, there were 1,015 acres of pasture in the Baltimore County portion of the Jones Falls watershed: in 2011, there were 957 acres (Table 5.2). Currently, pasture represents approximately 3.7% of the Baltimore County portion of the watershed. Using the most recent land use data from Maryland Department of Planning (2010), land classified as feeding operations and agricultural buildings was summarized. Feeding operations include cattle feed lots, holding lots for animals, hog feeding lots, and poultry houses. Agricultural buildings include breeding and training facilities, storage facilities, built-up areas associated with a farmstead, small farm ponds and commercial fishing areas. In 2008, in the Baltimore County portion of the Jones Falls watershed, there were zero acres classified as feeding operations and 14.4 acres classified as agricultural buildings.

5.1.5 Wildlife

Wildlife, mammals and waterfowl, are present in both the developed and undeveloped areas of the watershed. At this time, Baltimore County does not have a way to quantify the amount of wildlife in any given area.

5.2 The Human Modified Landscape

The natural landscape has been modified for human use over time. The intensity of this modification has increased, starting with the colonization of Maryland in the 1600s. This modification has resulted in environmental impacts to both the terrestrial and aquatic ecosystems. This section will provide a characterization of the human modified landscape and how that modification is associated with impacts to the natural ecosystem. The characterization will progress from the general characteristics of land use and land cover to specific issues including population, drinking water and wastewater, storm water systems, and sanitary sewer overflows, all of which contribute to bacteria in the watershed.

5.2.1 Land Use: Baseline and Current

The land use of an area has an influence on the water quality of the watershed. Forested land absorbs nutrients and slows the flow of water into streams. Roads, parking areas, roofs and other human constructions are collectively called impervious surface. Impervious surfaces block the natural seepage of rain into the ground. Unlike many natural surfaces, impervious surfaces typically concentrate stormwater runoff, accelerate flow rates and direct stormwater to the nearest stream. This can cause bank erosion and destruction of in-stream and riparian habitat. Watersheds with small amounts of impervious surface tend to have better water quality in local streams than watersheds with greater amounts of impervious surface.

Approximately 54% of the Baltimore County portion of the Jones Falls lies within the Urban Rural Demarcation Line (URDL) and 46% lies outside the URDL. The URDL is a growth limit line established in 1967 which prohibits public water and sewer outside the line to relegate growth to the inner suburbs.

The Jones Falls watershed is comprised of 25,933 acres or 40.5 square miles of land within Baltimore County. Land use data from the USGS National Land Cover Database (Jin, 2013) from 2001, 2006, and 2011 was combined with Baltimore County impervious surface data from 1995, 1996, 1997, 2001, 2005, and 2011. This combined land use land cover data was used to interpolate the baseline (2003) land use for Jones Falls. The land use distribution for Jones Falls for 2003 and current (using 2011 data) is shown in Table 5.2.

Table 5.2: Land Use in Jones Falls Watershed in Baltimore County at Baseline and Present

Land Type	2003 (Baseline year) Acres	2003 (Baseline year) Percent	Current (2011 data) Acres	Current (2011 data) Percent	Change since Baseline Acres	Change since Baseline Percent
Crop	1,122	4.33	1,131	4.36	+9	+0.80
Extractive	13	0.05	5	0.02	-8	-61.54
Forest	10,061	38.80	9,880	38.10	-181	-1.80
Pasture	1,015	3.91	957	3.69	-58	-5.71
Urban Impervious	3,753	14.47	4,131	15.93	+378	+10.07
Urban Pervious	9,896	38.16	9,747	37.59	-149	-1.51
Water	73	0.28	83	0.32	+10	+13.70

Land classified as crop includes cultivated crops. Pasture refers to land used as pasture and as hay. Extractive land use includes barren land and anything that is bare rock, sand, or clay. Land classified as forest includes forests, natural meadows/grassland, and wetlands. Urban impervious is developed land, including any structure (houses, shopping centers, etc.), roads, parking areas, and pavement. Urban pervious is any developed land cover that is not impervious including turf, gardens, bare soil, mulch, hedges, shrubs, and trees. Water includes any ponds, reservoirs, or other open water bodies in the watershed.

5.2.2 Population

Census block data from the 2000 US Census and 2010 US Census was used to determine the population in the watershed. Data from the 2000 US Census was interpolated in order to estimate the population for 2003, which is the baseline year for the TMDL and therefore important to understand the conditions at the time the TMDL was developed. The 2010 Census is the most recent census therefore there is not more recent data. Population for 2003 and 2010 and the percent change over time in the Jones Falls watershed Areas are shown in Table 5.3.

Table 5.3: Population of Jones Falls Watershed in Baltimore County

2003 (Baseline year)	Current (2010 data)	Percent change
61,924	64,881	4.77

5.2.3 Infrastructure

5.2.3.1 Wastewater

Wastewater created through human use must be treated and properly disposed of. This may be accomplished in two ways, either through individual wastewater treatment systems (septic systems) or through public conveyance to a treatment facility. Residential wastewater consists of all of the water that is typically used by residents, including, wash water, bathing water, human waste deposal water, and any other rinse water (paint brush, floor washing, etc.). Industrial operations must also dispose of any water used as part of their operation. Depending on the operation the water could contain any number of contaminants, including pathogens, metals, organic compounds, detergents, or synthetic compounds. All of these wastes have the potential to harm the natural environment.

5.2.3.2 Septic Systems

Properly functioning septic systems provide treatment for virtually all of the phosphorus, but leak nitrogen in the form of nitrates. Depending on the location of the system the nitrates may either be reduced or eliminated through denitrification as the water passes through riparian buffers, particularly forested riparian buffers. Failing systems can result in increased contamination of the aquatic environment through increased releases of nitrogen, phosphorus, and other chemicals. They can also result in increased bacterial contamination of the waterways and potential for human health concerns.

Using the Bay Restoration Fund 2014 data, we estimate 15.8% of the population of the Jones Falls watershed within Baltimore County are using septic systems.

5.2.3.3 Public Sewer System

A public sewer system conveys wastewater from individual residences or businesses to a facility that treats the wastewater prior to discharge. The part of the system that is in the public right-of-way is owned and maintained by the County government. The public system consists of the gravity piping system, access manholes, pumping stations, and force mains. Private property owners are responsible for the maintenance of the pipes and cleanouts located on their property.

Wastewater, like water, naturally flows downhill through pipes. These pipes are referred to as gravity pipes. However, sometimes it is necessary to be able to force the water in another direction, therefore creating a pressurized pipe or a force main. This scenario occurs in low lying areas. In order for the water to go against gravity, a pump is needed which is kept in a pump station. Table 5.4 shows length of sewer gravity pipe, pressurized pipe, and number of pumps stations in the Jones Falls watershed in Baltimore County.

Table 5.4: Sanitary Sewer Infrastructure in the Jones Falls Watershed in Baltimore County

Length of Gravity Pipe (miles)	Length of Pressurized Pipe (miles)	Number of Pump Stations
228.5	9.5	28

5.2.3.4 Sanitary Sewer Overflows (SSOs)

Environmental impacts associated with the public sewer system are usually the result of sewage overflows. These sanitary sewer overflows (SSOs) usually result from blockages within the sewage system, pumping station failure, or rainwater inflows exceeding the capacity of the pipe. There are several factors that may contribute to SSOs from a sewer system, including pipe capacity, operations and maintenance effectiveness, sewer design, age of system, pipe materials, geology and building codes. The U.S. EPA reports there are at least 40,000 of these incidents per year in the United States of America (U.S. EPA 2012). The environmental and human health consequences of these overflows can be serious. *E. Coli* bacteria and other pathogens can be present, posing health risks to individuals who may come in contact with contaminated water. Sewer overflows can also contain high levels of nitrogen and phosphorus that are toxic to aquatic life and feed organisms that deplete oxygen in waterways. High levels of sediment are also present in these overflows, which can clog streams and block sunlight from reaching essential aquatic plants. As of September 2005, Baltimore County is under a consent decree with the U.S. Environmental Protection Agency to repair, replace or rehabilitate the system with the goal of eliminating all overflow structures to be completed by March 2020. Between 2000 and 2013, there were 108 SSOs totaling 637,866 gallons. See Figure 5.2 for the distribution of SSO in Jones Falls watershed in Baltimore County from 2000-2013. Figure 5.3 shows the volume of SSOs per year and Figure 5.4 shows the number of the SSOs by cause in the Baltimore County portion of the Jones Falls watershed.

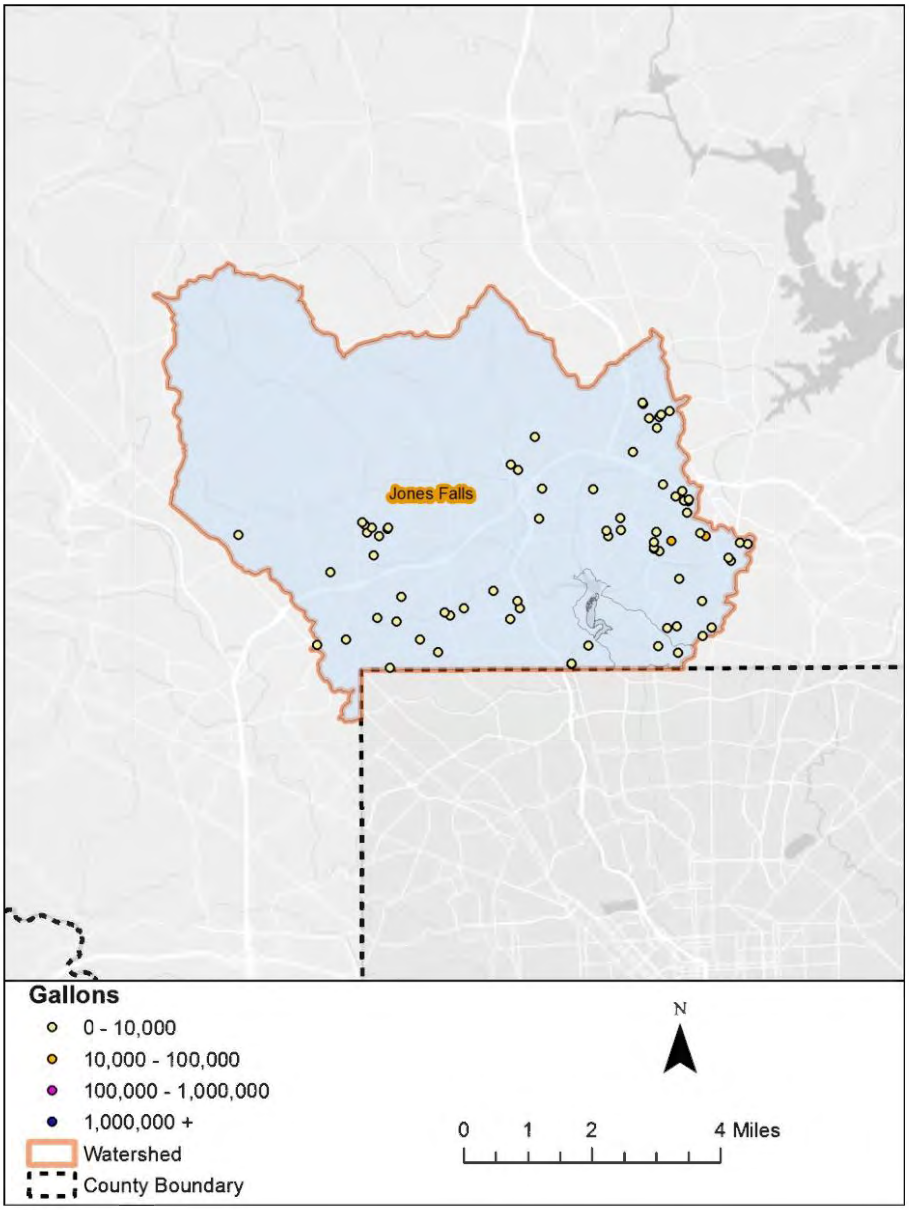

Figure 5.2: Location of SSOs in Jones Falls Watershed from 2000-2013

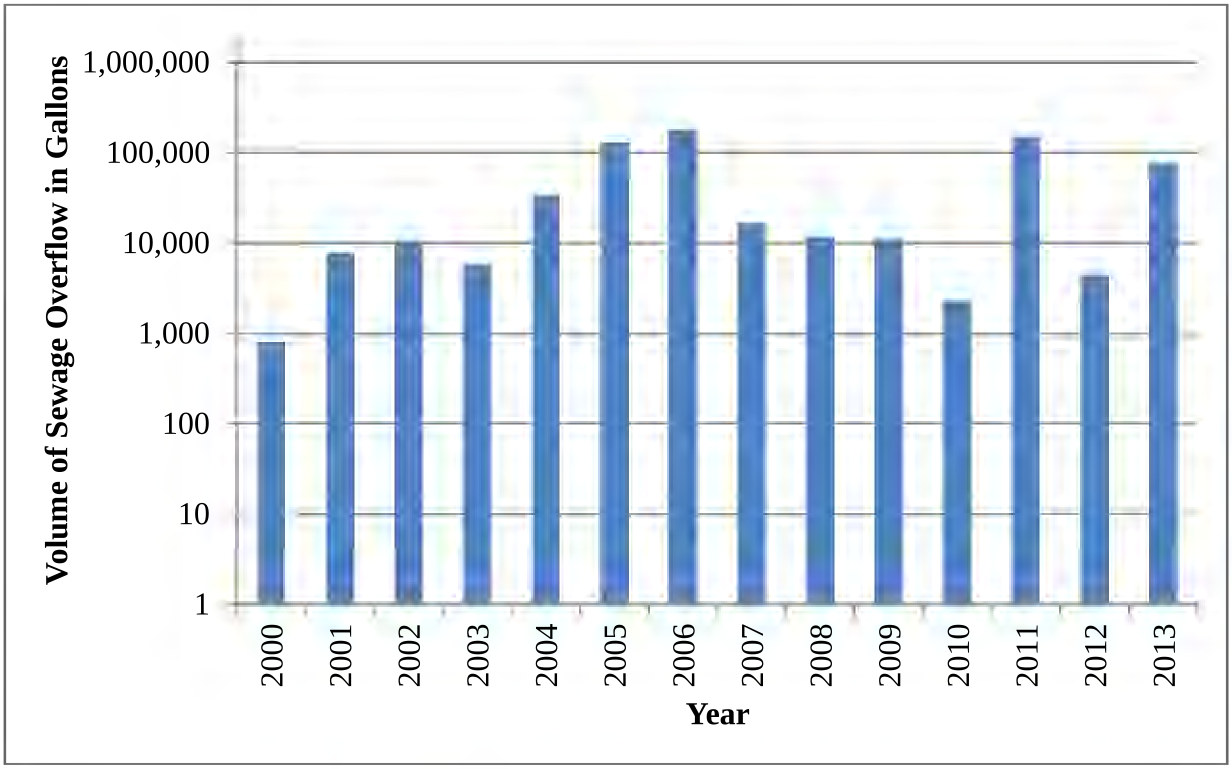

Figure 5.3: Volume of SSOs in Jones Falls Watershed per Year from 2000-2013

Figure 5.4: SSOs by Cause from 2000-2013

Baltimore County conducts bacteria water quality sampling for *Escherichia coli* (*E. coli*) in the Jones Falls watershed. This section discusses the data results from the monthly Bacteria Trend Monitoring Program. Major sources of *E. coli*, as described in the TMDL are domestic animals, humans, livestock, and wildlife.

6.1. Baltimore County Bacteria Trend Monitoring Program

Baltimore County EPS has coordinated with Baltimore City Surface Water Management Division to monitor bacteria trend levels over time at 5 monitoring locations within Jones Falls watershed, beginning in June 2010. This is part of the Bacteria Trend Monitoring Program that includes Baltimore County, Baltimore City, and Carroll County to monitor bacteria trends over time at 32 monitoring locations within one subwatershed and six major watersheds. The bacteria trend monitoring program was developed in response to the development of bacteria TMDLs in Herring Run, Gwynns Falls, Loch Raven, Prettyboy, Jones Falls, Liberty Reservoir, and the Lower North Branch of the Patapsco watersheds. Bacteria monitoring began in June 2010, with 16 sites in Baltimore County, and 11 sites in Baltimore City. Bacteria monitoring in Carroll County began in 2012 and includes 5 sites in Carroll County. Jones Falls trend monitoring samples are collected on the first Thursday of every month by Baltimore City, and are brought to the Baltimore County EPS lab for *E. coli* analysis using IDEXX methodology. Table 6.1 shows the latitude/longitude locations of the current bacteria monitoring stations within the Jones Falls watershed. Figure 6.1 shows the locations of the monitoring sites for the entire trend monitoring program. There are five bacteria trend monitoring sites in the Jones Falls. Two of the monitoring sites are in the city and three are in the county.

Table 6.1: Baltimore County Bacteria Monitoring Station Locations

MDE Station Code	County Code	Watershed/ Subshed	Latitude	Longitude	Location
JON0039	JON-1	Jones Falls	39.327	-76.640	City
JON0082	JON-2	Jones Falls	39.378	-76.644	County
JON0184	JON-3	Jones Falls	39.391	-76.661	County
UQQ005	JON-4	Roland Run	39.399	-76.649	County
SRU0005	JON-5	Stoney Run	39.326	-76.626	City

Figure 6.1: Map of Baltimore County/City, and Carroll County bacteria monitoring sites

6.1.1 Summary of Data Results

Samples are collected on the first Thursday of every month, except in circumstances of severe weather. Table 6.2 presents the number of samples and the geometric mean for high (wet) flow and low (dry) flow by year. It also presents the geometric mean of all samples by year regardless of condition. The table is stratified by annual data (includes all data collected for the year) and seasonal data (includes only those samples collected between May 1st and September 30th each year). Geometric means below the water quality standard (126 MPN) are highlighted in green. These results are displayed graphically in Figures 6.2 through 6.6.

Table 6.2: Jones Falls *E. coli* Results on an Annual and Seasonal Basis

Annual (MPN/100 ml)													
Site	**Flow Type**	**2010**		**2011**		**2012**		**2013**		**2014**		**2015**	
		N	**MPN**	**N**	**MPN**	**N**	**MPN**	**N**	**MPN**	**N**	**MPN**	**N**	**MPN**
JON-1 City	High	2	2,420	4	632	3	98	2	2,420	3	1684	3	930
	Low	5	942	8	605	8	547	8	328	8	317	8	273
	All	7	1,233	12	614	11	342	10	489	11	500	11	341
JON-2	High	2	703	4	173	3	32	2	24	4	442	3	840
	Low	5	187	8	46	9	283	10	28	7	55	8	30
	All	7	273	12	71	12	55	12	27	11	117	11	80
JON-3	High	2	1,119	4	460	3	240	2	748	4	751	3	300
	Low	5	761	8	65	9	94	10	82	8	104	8	95
	All	7	849	12	124	12	119	12	118	12	201	11	145
JON-4	High	2	1,119	4	716	3	449	2	2,420	4	688	3	508
	Low	5	696	8	111	9	64	10	60	8	186	8	125
	All	7	797	12	207	12	105	12	110	12	288	11	191
JON-5 City	High	2	2,420	4	973	3	200	2	2,420	4	1151	3	721
	Low	5	373	8	360	9	182	9	200	8	230	8	167
	All	7	636	12	502	12	186	11	315	12	394	11	249
Seasonal (May 1st to September 30th) (MPN/100 ml)													
Site	**Flow Type**	**2010**		**2011**		**2012**		**2013**		**2014**		**2015**	
		N	**MPN**	**N**	**MPN**	**N**	**MPN**	**N**	**MPN**	**N**	**MPN**	**N**	**MPN**
JON-1 City	High	0		2	751	1	**	1	2,420	2	2420	1	1046
	Low	4	1,210	3	538	4	824	4	283	3	706	3	161
	All	4	1,210	5	615	5	215	5	434	5	1155	4	257
JON-2	High	0		2	228	1	75	1	63	2	1087	1	1553
	Low	4	147	3	186	4	35	4	17	2	113	3	30
	All	4	147	5	202	5	40	5	49	4	351	4	81
JON-3	High	0		2	551	1	387	1	770	2	1053	1	866
	Low	4	994	3	377	4	254	4	266	3	549	3	188
	All	4	994	5	439	5	277	5	329	5	712	4	276
JON-4	High	0		2	2,178	1	210	1	2,420	2	1365	1	2420
	Low	4	889	3	869	4	251	4	152	3	305	3	295
	All	4	889	5	1,255	5	242	5	684	5	555	4	500
JON-5 City	High	0		2	773	1	166	1	2,420	2	1773	1	1414
	Low	4	311	3	275	4	93	4	479	3	372	3	376
	All	4	311	5	416	5	105	5	662	5	695	4	524

** Data suspect, results indicated 1 MPN/100 ml

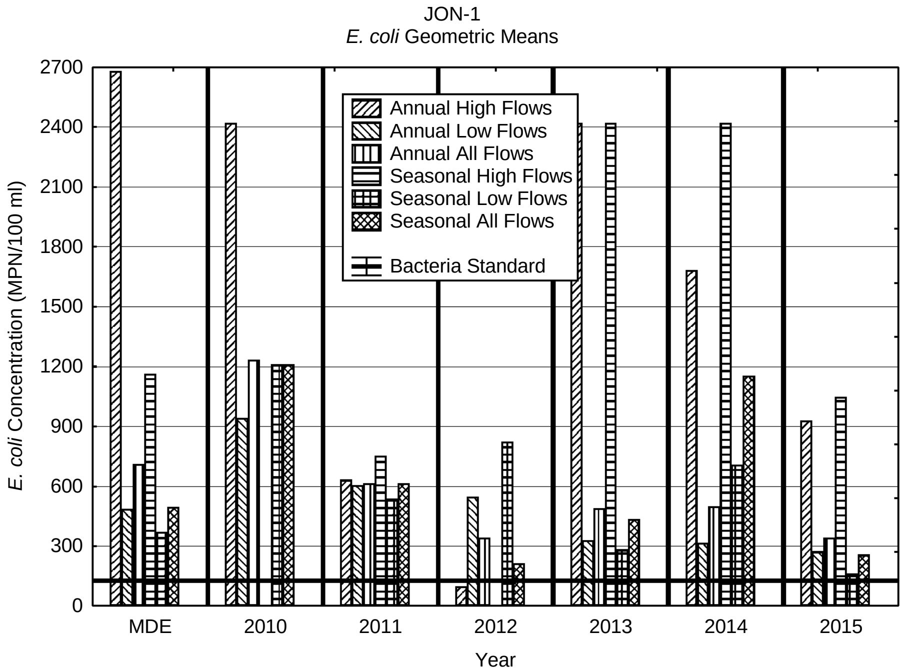

Figure 6.2: *E. coli* Geometric Mean Concentrations at Site JON-1 for both Annual and Seasonal Flow Periods Stratified by Flow Condition, MDE Results Added for Comparison

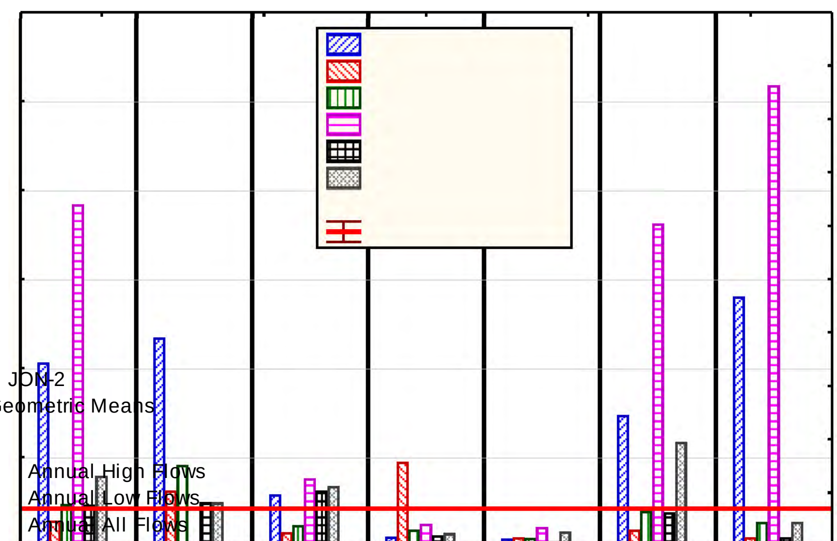

Figure 6.3: *E. coli* Geometric Mean Concentrations at Site JON-2 for both Annual and Seasonal Flow Periods Stratified by Flow Condition, MDE Results Added for Comparison

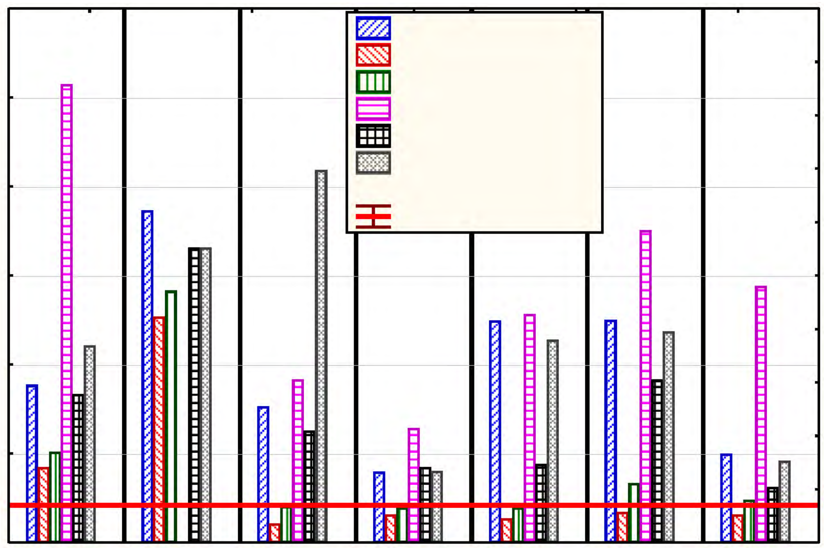

Figure 6.4: *E. coli* Geometric Mean Concentrations at Site JON-3 for both Annual and Seasonal Flow Periods Stratified by Flow Condition, MDE Results Added for Comparison

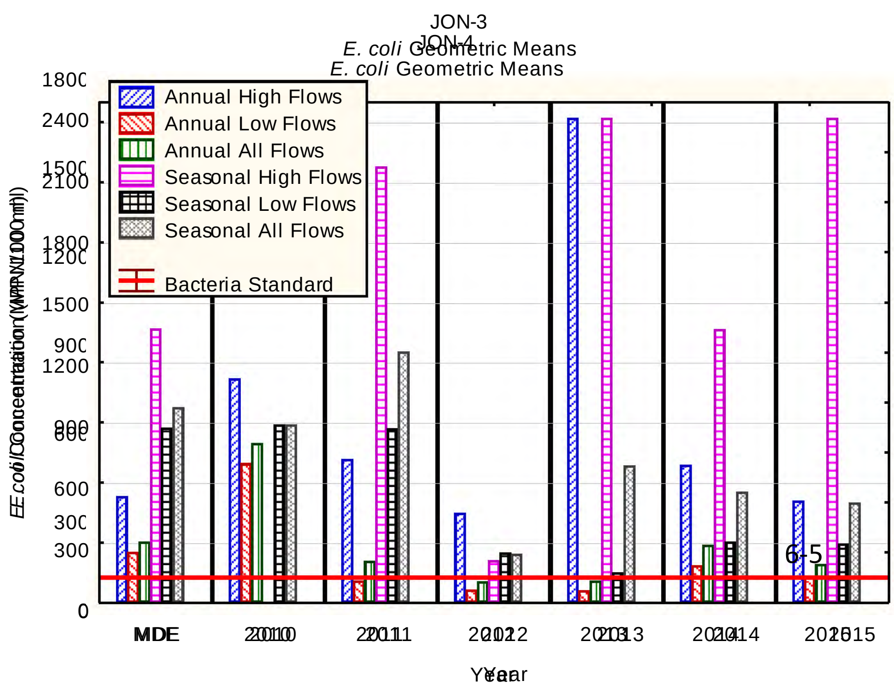

Figure 6.5: *E. coli* Geometric Mean Concentrations at
Stratified by Flow Condition, MDE Results Added for Comparison

Site JON-4 for both Annual and Seasonal Flow Periods

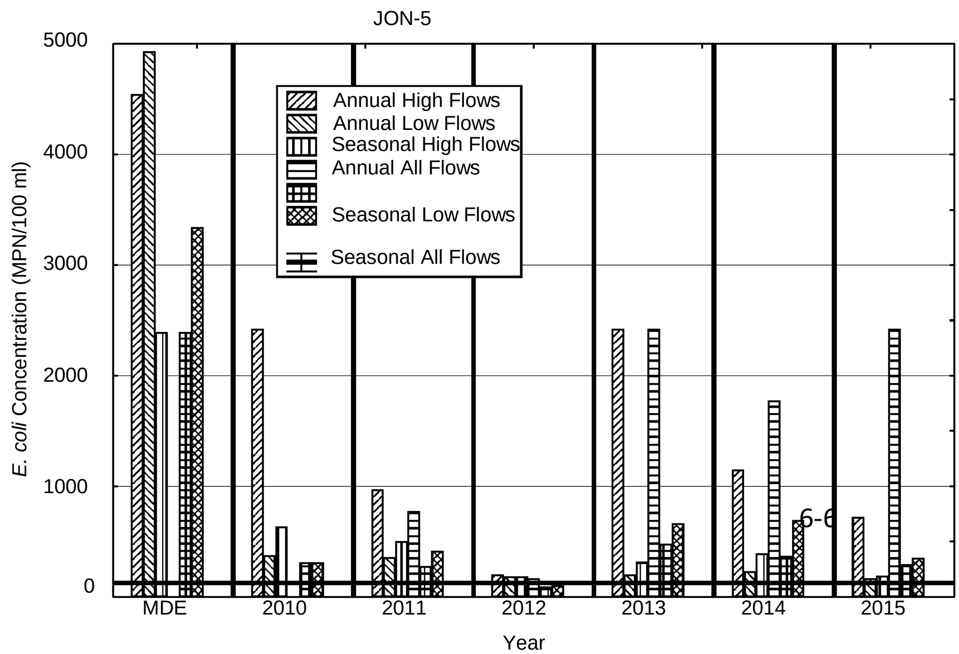

Figure 6.6: *E. coli* Geometric Mean Concentrations at Site JON-5 for both Annual and Seasonal Flow Periods Stratified by Flow Condition, MDE Results Added for Comparison

JON-1 (JON0039): This site is the located in Baltimore City on the mainstem of the Jones Falls and is the lowest monitoring point on the mainstem. It receives drainage from both Baltimore County and Baltimore City. The monitoring site is located above the confluence with Stoney Run. While the data indicate an improving trend over six years of monitoring for annual low flow conditions, the geometric mean for all conditions is still higher than the water quality standard of 126 MPN/100 ml for *E. coli*. The Maryland Department of the Environment (MDE) data for this site had a geometric mean of 372 MPN/100ml for dry weather seasonal samples based on monitoring conducted between 10/2002 and 6/2003. A weighted mean for dry weather seasonal sampling for the six years of monitoring conducted by Baltimore County resulted in a value of 527 MPN/100ml. This would indicate the conditions are worsening at this station based on the difference between the two monitoring periods. The TMDL requires a 95.3% reduction of bacteria at this site.

JON-2 (JON0082): This monitoring site is located on the mainstem of Jones Falls in Baltimore County, below the Lake Roland dam. The entire drainage area is in Baltimore County. The Baltimore County monitoring indicated that this site has displayed continuing improvement for both low flow and high flow on an annual and a seasonal basis. However, beginning in 2014, the high flow regimes have shown a marked increase over previous years' averages, while the other flow regimes remained relatively stable. The MDE data for this site indicated a seasonal dry weather geometric mean of 139 MPN/100ml for this site. The six years of Baltimore County data resulted in a geometric mean of 74 MPN/100 ml for the dry weather seasonal data. This would indicate that there has been improvement at this site. The TMDL indicated a reduction of 95.3% reduction necessary for meeting bacteria water quality standards in the drainage area to this site. Based on the Baltimore County monitoring data, this site may have had enough bacteria reduction to meet the bacteria water quality standards. Monitoring will continue at this site to confirm that bacteria water quality standards are being met.

JON-3 (JON0184): This is located on the mainstem of Jones Falls in Baltimore County upstream of Lake Roland at the Sorrento Run USGS gage. The entire drainage area is in Baltimore County. The Baltimore County monitoring data indicates that the bacteria concentrations are improving, particularly for low flow conditions. Low flows taken annually have met bacteria standards every year since 2011. The other flow regimes have been more variable, but have generally returned to levels seen in 2012, after high years in 2013 and 2014. The MDE data indicated a seasonal dry weather concentration of 501 MPN/100ml for this site, while the Baltimore County data, geometric mean for six years shows a concentration of 376 MPN/100ml indicating improvement. The TMDL requires 92.4% reduction for meeting bacteria water quality standards at this site.

JON-4 (UQQ005): This site is located in Baltimore County on Roland Run upstream from Lake Roland. The entire drainage is in Baltimore County and represents an urban subwatershed. The Baltimore County monitoring data indicates improving trends for low flow on both an annual basis and a seasonal basis. The annual low flow geometric means met the bacteria water quality standards between 2011 and 2013, but has since exceeded the standard every year. However, the seasonal low flow, while improving, has yet to meet the bacteria water quality standards. The MDE data indicated a seasonal dry weather concentration of 872 MPN/100ml for this site, while the Baltimore County data for six years of monitoring resulted in a geometric mean concentration of 365 MPN/100ml; indicating improvement at this site. The TMDL indicated a 92.1% reduction is necessary for meeting bacteria water quality standards at this site.

JON-5 (SRU0005): This site is located on Stoney Run in Baltimore City. A very small portion of the drainage area is in Baltimore County just above the city line. Since 2013, many flow regimes have shown decreasing or relatively steady geometric means, but still higher than those observed in 2012. Continued monitoring will determine if there is a consistent improvement of bacteria concentrations at this site. The MDE data indicated a seasonal dry weather concentration of 2,394 MPN/100ml at this site based on monitoring in 2002-2003, while the Baltimore County data for the six years of monitoring results in a geometric mean of 278 MPN/100 ml for the seasonal dry weather samples. This would indicate a significant improvement between the two monitoring periods. The TMDL indicated a 97.8% reduction in bacteria loads as necessary to meet bacteria water quality standards.

In addition to analyzing the data for the geometric means, the data were analyzed based on the single sample exceedance for seasonal data (May 1st to September 30th). Single sample exceedance standards are based on frequency of full body contact, ranging from infrequent (576 MPN) to frequent (235). The objective in the control of bacteria is to not only meet the geometric mean water quality standards, but to also meet the single sample water quality standards. This is particularly important for the low flow (dry weather) component of the flow regime, as this is when human recreational use of water is most likely to occur. Table 6.3 presents the results of the analysis by station, by year and by flow regime. The zero percent exceedances are highlighted in green.

Table 6.3: Frequency of Exceedance of Single Sample Water Quality Standards

Site	Year	N		Percent Single Sample Exceedance (MPN)							
		Flow Type		576		410		298		235	
		High	Low	High	Low	High	Low	High	Low	High	Low
JON-1	2010	0	4		100%		100%		100%		100%
	2011	2	3	100%	67%	100%	67%	100%	67%	100%	67%
	2012	1	4	0%	75%	0%	100%	0%	100%	0%	100%
	2013	1	4	100%	25%	100%	25%	100%	50%	100%	75%
	2014	2	3	100%	100%	100%	100%	100%	100%	100%	100%
	2015	1	3	100%	0%	100%	0%	100%	0%	100%	0%
JON-2	2010	0	4		25%		25%		25%		25%
	2011	2	3	50%	0%	50%	33%	0%	33%	0%	67%
	2012	1	4	0%	0%	0%	0%	0%	0%	0%	0%
	2013	1	4	0%	0%	0%	0%	0%	0%	0%	0%
	2014	2	2	50%	0%	100%	0%	100%	0%	100%	0%
	2015	1	3	100%	0%	100%	0%	100%	0%	100%	0%
JON-3	2010	0	4		75%		100%		100%		100%
	2011	2	3	50%	0%	50%	33%	50%	100%	100%	100%
	2012	1	4	0%	50%	0%	75%	100%	75%	100%	75%
	2013	1	4	100%	50%	100%	50%	100%	50%	100%	50%
	2014	2	3	100%	67%	100%	67%	100%	67%	100%	100%
	2015	1	3	100%	0%	100%	0%	100%	67%	100%	67%
JON-4	2010	0	4		75%		75%		75%		100%
	2011	2	3	100%	100%	100%	100%	100%	100%	100%	100%
	2012	1	4	0%	25%	0%	75%	0%	75%	0%	75%
	2013	1	4	100%	25%	100%	25%	100%	25%	100%	25%
	2014	2	3	100%	0%	100%	33%	100%	67%	100%	67%
	2015	1	3	100%	0%	100%	33%	100%	33%	100%	67%
JON-5	2010	0	4		75%		75%		75%		75%
	2011	2	3	50%	33%	50%	33%	50%	33%	100%	33%
	2012	1	4	0%	0%	0%	0%	0%	25%	0%	25%
	2013	1	4	100%	25%	100%	25%	100%	25%	100%	75%
	2014	2	3	100%	0%	100%	33%	100%	67%	100%	100%
	2015	1	3	100%	67%	100%	67%	100%	100%	100%	100%

The frequency of exceedance at site JON-2 during high flows has not returned to its levels previous to 2014, but this may be a factor of small sample size, as it has not exceeded any standard during low flow conditions since 2011. The other four sites are more variable in results with no specific trends noted. The new trend sites had at least one exceedance during 2015. Further monitoring is needed at these sites in order to detect trends.

The bacteria trend monitoring program will continue until such time as all bacteria water quality standards are met in the Jones Falls watershed.

6.4 Summary of Current Condition

Based on the results of the current trend monitoring program, sampling indicates that while improvements have occurred, additional work is necessary to meet the bacteria water quality standards, particularly with respect to high flow concentrations.

Section 7 - Summary of Existing Restoration Plans

Baltimore County has already developed management plans that aim to remove certain pollutants in parts of the Jones Falls watershed. Section 7.1 is a brief summary of the Northeastern Jones Falls Small Watershed Action Plan (SWAP). Section 7.2 is a brief overview of the Lower Jones Falls SWAP and section 7.3 is a description of the Jones Falls Watershed Management Plan. SWAPs include local based goals and objectives that are beyond the scope of the TMDL IP. All completed SWAP documents and their appendices are available online. Past studies, including these SWAPs and the Watershed Management Plan, were used to inform the Implementation Plan. The following subsections provide more specific information for each plan within the Jones Falls watershed.

7.1 Northeastern Jones Falls Small Watershed Action Plan, 2012

The *Northeastern Jones Falls SWAP* addresses a 10.9 square mile portion of the Jones Falls watershed, making up the north eastern part of the Jones Falls watershed that is within Baltimore County. Northeastern Jones Falls includes the four sub-watersheds: Roland Run, Ruxton Run, Towson Run, and the Lake Roland Direct Drainage. The Northeastern Jones falls represents 19% of the entire Jones Falls watershed.

The SWAP is a strategy for restoring the Northeastern Jones Falls. It was developed, in 2012, by Baltimore County Department of Environmental Protection and Sustainability with extensive input from county citizens, county agencies, members of watershed associations, and various institutions. The action plan outlines recommendations for watershed restoration, describes management strategies for each of the four sub watersheds, and identifies priority projects for implementation. The plan also includes cost estimates for certain potential actions and a schedule for implementation over a 13 year timeline. Financial and technical partners are suggested for implementation of various potential actions.

7.1.1 SWAP Vision and Goals

Northeastern Jones Falls SWAP Vision:

The Northeastern Jones Falls Steering Committee adopted the following vision statement that served as a guide in the development of the SWAP:

We envision a healthy, vibrant Northeastern Jones Falls watershed, which protects high quality streams and is supportive of diverse aquatic life. Our watershed conserves treasured natural resources and maintains and celebrates our residential character and landscape for today and for future generations.

Northeastern Jones Falls SWAP Goals:

- Goal 1: Improve and Maintain Clean Water
- Goal 2: Enhance Stream Riparian Corridors for Water Quality and Habitat Value
- Goal 3: Increase Citizen Participation with Restoration Projects
- Goal 4: Encourage Collaboration with the Institutional Landowners and Baltimore County EPS on Restoration Projects
- Goal 5: Enhance Natural Resources on Public Property
- Goal 6: Maintain the Residential Character of the Watershed

7.2 Lower Jones Falls Watershed Small Watershed Action Plan, 2008

The *Lower Jones Falls SWAP* addresses the southern portion of the Jones Falls watershed, including the area that crosses over into Baltimore City. The area includes six sub-watersheds and makes up 45% of the Jones Falls watershed. The Lower Jones falls is 25.9 square miles of the entire 58 square miles of the Jones Falls watershed.

This small watershed action plan was developed by a partnership between Baltimore County, Baltimore City, the Herring Run and Jones Falls Watershed Associations, and the Center for Watershed Protection Inc. The plan presents results of a thorough watershed assessment by sub-watershed, conceptual storm water retrofit project plans, overall watershed recommendations, and a draft schedule for implementation with anticipated benefits of implementation.

7.2.1 SWAP Goals

The stakeholder meetings resulted in the following set of goals to guide recommendations for the lower Jones Falls SWAP:

- Goal 1: Improve conditions in stream to achieve standards of swimmable, fishable, and water contact recreation in streams by 2022.
- Goal 2: Improve the condition of the biology in the stream by planting more stream buffers along streams and removing concrete stream channels.
- Goal 3: Implement effective watershed education.
- Goal 4: Increase the involvement of the population
- Goal 5: Disconnect impervious surfaces from the storm drain system
- Goal 6: Integrate stormwater and watershed planning goals in new and redevelopment.
- Goal 7: Continue collaboration between Baltimore City/County, watershed groups and citizens.
- Goal 8: Engage the business community in restoration
- Goal 9: Improve management of natural and turf areas

7.3 Jones Falls Watershed Management Plan (1998)

The WQMP for Jones Falls is a document that details Capital Improvement Projects (CIPs) that the County could consider to improve water quality. These Management Plans focused on County-specific actions, and not citizen-based initiatives. The plans outlined in the WQMP may be useful for determining CIPs that the County may still implement through this plan and in the future. The SWAPs include some additional CIPs along with various citizen-based plans that can reinforce the efforts of the County. The full plan is available for review at the EPS offices at 111 W. Chesapeake Ave. Towson, MD 21204.

This section provides an overview of pollutant reduction measures and their predicted effectiveness. This overview is meant to serve as a guide to aid in selecting the most efficient possible BMPs that may be implemented to meet the pollutant reduction goals required by the TMDL. This review utilizes conservative estimates of BMP efficiency for planning purposes, as exact types of BMPs (e.g. structural BMPs) will not be chosen until appropriate on-site analysis is complete. It is possible that only some of the listed actions in this section will be selected for inclusion in Section 9 of this Implementation Plan

Bacteria can be removed from or inactivated in surface waters and stormwater through several treatment mechanisms by implementing Best Management Practices (BMPs). Treatment mechanisms include ultraviolet light (from sunlight), sedimentation, settling, plant uptake, drying, temperature, and filtration. Bacteria require specific environmental conditions to thrive and survive (Clary et al. 2010; Hathaway and Hunt 2008). BMPs commonly have moist soils and readily available nutrients, conditions that may be conducive to pathogen persistence. In some instances, BMPs can be sources of pathogens. This occurs in BMPs which attract wildlife including deer, waterfowl, rodents, and domestic animals which defecate in and around the BMP resulting in direct pathogen inputs to the system (Hathaway and Hunt 2008).

Removal efficiencies are typically calculated by comparing contaminant concentrations or loads entering and exiting a structural control (US DOI 2002). Removal efficiencies of structural controls depend on many factors including the type and design; site characteristics such as soil type, catchment size, land use, percent impervious area, storm size and intensity, bypass issues, maintenance and upkeep of the systems, and retention time (US DOI 2002). BMP systems rather than individual BMP installation tends to work better (Haynes 2006).

Several sources were consulted including the International BMP Database, research studies, and other existing TMDL implementation plans. Below is a description of several BMPs that have been studied for removal of bacteria and Table 8.1 summarizes the efficiencies of each BMP.

8.1 Types of Best Management Practices for Addressing Bacteria

8.1.1 Sanitary Sewer Repairs

Sanitary Sewer Overflows (SSOs) occur when the capacity of a sanitary sewer is exceeded. There are several factors that may contribute to SSOs from a sewer system, including pipe capacity, operations and maintenance effectiveness, sewer design, age of system, pipe materials, geology and building codes. As of September 2005, Baltimore County is under a consent decree with the U.S. Environmental Protection Agency (EPA) to repair, replace or rehabilitate the system with the goal of eliminating all overflow structures to be completed by March 2020 (US EPA et al. 2006). It is assumed that there will be a 95% bacteria efficiency removal.

8.1.2 Grass Swales/Bioswale

Grass swales are vegetated open channels designed to treat stormwater runoff by slowing the water to allow sedimentation and filtering as the water flows along these channels. Grass swales are typically located along roads because they are linear. They should be sited on relatively flat sites as steep slopes encourage erosion. Grass swales typically do not have a high efficiency of bacteria removal, in fact several studies have shown a negative bacteria removal efficiency (-50%) which indicates more bacteria left the system than entered (US EPA 2012a). This may be because swales are attractive to animals and are not necessarily intended to completely dry between storms, potentially providing an environment where pathogens can persist (Hathaway and Hunt 2008).

8.1.3 Riparian Buffer Zones

Riparian buffer zones are vegetated areas along streams to reduce erosion, sedimentation, and pollution of water (US EPA 2012a). Densely vegetative cover removes pollutants through detention of runoff, filtration by the vegetation, and infiltration into soil (BoyerND). The effectiveness of buffers for reducing bacteria pollution, however, is dependent on the type of vegetation and the width of the buffer. Typically, the wider the buffer, the more pollution reduced. The VA DEQ Guide reports a bacteria removal efficiency of 43-57% (VA DECR and VA DEQ 2003).

8.1.4 Dry Detention Ponds

Dry detention ponds are basins whose outlets have been designed to detain stormwater runoff for some minimum time (e.g., 24 hours) to allow particles and associated pollutants to settle. They do not have a large permanent pool of water but are often designed with small pools at the inlet and outlet of the basin or can be completely dry between precipitation events (Hathaway et al. 2009; US EPA 2012a). The primary pollutant removal mechanisms are sedimentation, drying, and sun exposure (Hathaway et al. 2009). Studies show detention ponds have a bacteria removal efficiency of 25% (VA DECR and VA DEQ 2003).

8.1.5 Retention Ponds/Wet Ponds

Retention ponds/wet ponds are basins where influent runoff enters the pond and theoretically replaces captured runoff from prior events (the principle of plug flow) (Hathaway et al. 2009). The wet pond retains the runoff for 1-2 days and then slowly drains (Hathaway and Hunt 2008). Bacteria removal is facilitated through settling (sedimentation), plant uptake and sun exposure (Hathaway et al. 2009; Hathaway and Hunt 2008). According to Emmons and Olivier Resources, Inc. and the EPA, literature review studies cite average bacteria removal rates of 65-70% (Tilman et al. 2011; US EPA 2012a).

8.1.6 Bioretention/Biofiltration Ponds

Bioretention areas function as filtration and infiltration BMPs. Storm water enters the system and passes through a permeable soil media where pollutants are filtered, similar to sand filter systems, and are also vegetated. The system may pond water; however, it is drained within 12–24 hours. Tree box filters are smaller versions of bioretention systems which are installed along sidewalks as vegetated catch basins. The actual collection or entry point is typically a concrete structure with a catch basin or gutter opening integrated with the street curbing. Treated runoff is filtered into the groundwater or transported to the storm sewer system. The bioretention system is intended to dry out between storm events (Hathaway et al. 2009). Literature review studies cite average bacteria removal rates of 70% (Tilman et al. 2011).

8.1.7 Wetland Treatment Systems

Wetland treatment systems consist of a wetland constructed with the purpose of treating wastewater or stormwater inputs. The wetlands may be vegetated, open water, or a combination (Tilman et al. 2011). These BMPs promote sedimentation like wet ponds, but provide more exposure of captured stormwater to wetland soils and plants in a shallow system (Hathaway et al.

2009). Sun exposure in the open areas and natural die-off are thought to reduce the bacteria population (Tilman et al. 2011). Research studies found average measured bacteria removal efficiencies for wetland systems of 79% (Tilman et al. 2011). The level of bacteria reduction has been shown to increase as the treatment time (e.g., longer than 1-2 days) increases (Khatiwada and Polprasert 1999).

8.1.8 Sand Filters

Sand filters are a storm water treatment practice designed to remove sediment and pollutants from the first flush of runoff from pavement and impervious areas after a rain or storm event (Boyer, ND). Runoff first enters a sedimentation chamber before flowing through a column of soil. Sand chamber is dry between events. Treatment mechanisms relevant to pathogen removal include drying, sedimentation and filtration (Hathaway and Hunt 2008). Stormwater Best Management practices database (2010) indicated that sand filters are effective in removing from 36 to 83% of the bacteria in urban runoff.

8.1.9 Infiltration Basin

An infiltration basin is a shallow vegetated open impoundment where incoming stormwater runoff is stored until it gradually infiltrates into the soil. Runoff enters the basin and bacteria are removed through detention and filtration. Limitations include the need for permeable soils to reduce the potential for clogging and the need for regular maintenance. The VA DEQ Guidance Manual cites infiltration basins can provide 50% bacteria removal efficiency (VA DECR and VA DEQ 2003).

8.1.10 Infiltration Trench

An infiltration trench is an excavated trench that has been lined with filter fabric and backfilled with stone to form an underground basin or reservoir (Boyer Year Unknown; VA DECR and VA DEQ 2003). Stormwater runoff is directed into the trench through the use of grass areas or pretreatment devices. Trenches tend to be more suitable for ultra-urban situations, where the soil has low permeability (Boyer Year Unknown). The VA DEQ Guidance Manual cites infiltration trenches can provide 50% bacteria removal efficiency (VA DECR and VA DEQ 2003).

8.1.11 Porous Pavement

Porous or pervious pavement allows rainfall to percolate through it to the subbase, providing storage and enhancing soil infiltration that can be used to reduce runoff and combined sewer overflows. The water stored in the subbase then gradually infiltrates the subsoil (VA DECR and VA DEQ 2003). According to the VA DEQ Guidance Manual (2003), porous pavement can provide 50% bacteria removal efficiency.

8.1.12 Stream Bank Protection and Stabilization

Waterways that are being eroded can be stabilized by constructing bulkheads, using riprap, gabion systems or establishing vegetation which can reduce the amount of bacteria, nutrients, and sediment from entering the waterway (VA DECR and VA DEQ 2003). Stream bank protection and stabilization can provide for 40-75% bacteria removal efficiency (40% without fencing and 75% with fencing) (VA DECR and VA DEQ 2003).

8.1.13 Public Education – Pet Waste

Public education and outreach are important tools for reducing bacterial pollution due to pet waste. A pet waste education program would educate pet owners to better understand the importance of appropriate pet waste management practices. This program will include the development and distribution of educational materials and the promotion of pet waste BMPs. Public education for pet waste can provide for 25% bacteria removal efficiency (VADEQ 2013).

8.1.14 Street Sweeping

There are three types of street sweepers commonly used: mechanical, vacuum-assisted, and regenerative air (US DOI 2002). The most common type of sweeper, the mechanical sweeper, lifts dirt off the street by a rotating broom and feeds it to a hopper by a conveyor system. A water spray is often used to control dust. Vacuum-assisted sweepers combine a mechanical sweeper with a high-power vacuum. Some use a water spray to control dust. Regenerative-air sweepers combine a mechanical sweeper to loosen dirt with forced air to dislodge the remaining dirt. Street sweeping frequency is an important variable in the effectiveness of removing contaminants (US DOI 2002). For example, sweeping the street at least once between storms is important to remove contaminants before they are washed away by storms. Removal efficiencies are highest for suspended solids, intermediate for removal of lead, and lowest for fecal coliform bacteria and total phosphorus (US DOI 2002). Multiple passes with the street sweeper and the speed of the street sweeper also can affect the removal capabilities. Simulation models developed by USGS show a fecal coliform removal efficiency of 1.3-5.3%, depending on sweeping frequency and land use (US DOI 2002).

8.1.15 Redevelopment

Redevelopment consists of applying new uses to previously occupied urban space. This can sometimes involve a change in zoning or land use all together, or simply finding new uses for existing structures. In many cases this can allow for a site that previously had no water quality treatment practices to incorporate them into the new development.

Table 8.1: Reduction Efficiencies for BMPs treating Bacteria

Best Management Practice	Efficiency
Sanitary Sewer Overflow repairs	100%
Grass swale	-50%
Riparian buffer zone	43-57%
Dry detention ponds	25%
Retention ponds	65-70%
Bioretention/Biofiltration ponds	70%
Wetland treatment systems	79%
Sand filters	30%
Infiltration basin	50%
Infiltration trench	50%
Porous pavement	50%
Stream bank protection and stabilization (no fencing)	40%
Stream bank protection and stabilization (with fencing)	75%
Public education – pet waste	25%
Street sweeping	1.3-5.3%
Redevelopment	Varies

Please note, while some BMPs provide ranges, the lowest efficiency have been used in calculations to determine the acres treated by each BMP.

8.2 Agricultural and Septic System BMPs

8.2.1 Animal Waste Storage Facility

A waste storage area is made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure in order to temporarily store wastes such as manure, wastewater, and contaminated runoff (Peterson et al. 2011). An optimal use of waste storage is to improve the timing of manure applications so that manure nutrients are distributed to fields based on crop and soil needs, instead of repeated applications on the same field based on convenience (Peterson et al. 2011). Long-term manure storage (6-30 weeks) resulted in the reducing *E. coli* by 97% (Peterson et al. 2011).

8.2.2 Exclusionary Fencing

Livestock with access to streams introduces direct deposits of fecal matter and bacteria into the waterway. By limiting access of livestock to waterways with a constructed barrier has 75% bacterial removal efficiency (VA DECR and VA DEQ 2003).

8.2.3 Livestock Water Crossing Facility

Providing a controlled crossing for livestock and/or farm machinery in order to prevent streambed erosion and reduce sediment can also reduce bacteria in streams (VA DECR and VA DEQ 2003). Stream crossings can reduce *E. coli* 46% when combined with other practices (Peterson et al. 2011).

8.2.4 Alternative Water Sources

Providing livestock access to an off-stream drinking water source such as a trough or pond system decreases the amount of direct livestock use of streams for drinking and other activities (Peterson et al. 2011). An off-stream alternative water supply can result in a 85% bacteria removal efficiency (Peterson et al. 2011).

8.2.5 Range and Pasture Management

Range and pasture management refers to systems of practices to protect the vegetative cover on improved pasture and native rangelands. It includes practices such as seeding or reseeding, brush management (mechanical, chemical, physical, or biological), proper stocking rates and proper grazing use, and deferred rotational systems. Range and pasture management results in 50% bacteria removal efficiency (VA DECR and VA DEQ 2003).

8.2.6 Septic System Pump-Out

The greatest threat to surface water bacteria impairment originates from system failure when septage comes to the soil surface and results in overland flow (VA DECR and VA DEQ 2003). A typical septic system consists of a tank that receives waste from a residence or business, and a drain field or subsurface absorption system consisting of a series of percolation lines for the disposal of the liquid effluent. Solids (sludge) that remain after decomposition by bacteria in the tank must be pumped out periodically in order to prevent septic failure. Regular septic system pump-outs can result in 5% bacteria removal efficiency (VA DECR and VA DEQ 2003).

Table 8.2: Reduction Efficiencies for Bacteria for Agricultural and Septic BMPs

Best Management Practice	Bacteria Removal Efficiency
Animal waste storage facility	97-99%
Exclusionary fencing	75%
Livestock water crossing facility	46%
Alternative water sources	85%
Range and pasture management	50%
Septic pump-out	5%

8.3 Discussion of Uncertainty

Literature reviews have shown that pathogen removal appears to vary not only by BMP type, but also among similar BMP types at various locations (Clary et al. 2010; Hathaway and Hunt 2008). For example, there is considerable variability in the effectiveness of wet ponds, and it is believed that properly designing and maintaining ponds may help to improve their performance (Clary et al. 2010; US EPA 2012). Based on the performance data available to date in the BMP Database for fecal indicator bacteria, only general inferences regarding BMP selection are appropriate at this time. General recommendations as a result of the analysis include:

- In general, bioretention and sand filters appear to have ability to remove pathogens; these systems have little input from animals due to their lack of standing water, eliminating a common attraction for waterfowl (Clary et al. 2010; Hathaway and Hunt 2008).
- Conversely detention ponds and grass swales have not been shown to be very effective. Swales are attractive to animals and are not necessarily intended to completely dry between storms, potentially providing an environment where pathogens can persist (Clary et al. 2010; Hathaway and Hunt 2008).
- Seasonal distribution of samples may affect conclusions drawn related to BMP performance (Clary et al. 2010). For example, winter concentrations of fecal indicator bacteria may be lower than summer concentrations (Clary et al. 2010).

The majority of conventional stormwater BMPs in the BMP Database do not appear to be effective at reducing fecal indicator bacteria concentrations to primary contact stream standards, which is the ultimate target of TMDLs. Because the data are limited, both in the number of data points and the representativeness of the data, rigorous statistical conclusions cannot be drawn based on available data. Significantly more studies are needed for all BMP types to increase the confidence of performance estimates with regard to bacteria (Clary et al. 2010).

8.4 Alternative BMPs

8.4.1 Sanitary Sewer Lateral Line Program

The consent decree addresses sanitary sewer pipes that are located on public property. The connection between private owners and the county portion are referred to as lateral lines. These lateral lines are also prone to leaking which can result in bacteria entering waterways. If water quality standards are not achieved through the consent decree and other BMPs to address bacteria, the County will assess the feasibility of developing a program to monitor bacteria that may be the result of leaking lateral lines.

8.4.2 Stormtech Isolator Row

Stormtech Isolator Row is a manufactured treatment device that uses a series of subsurface chambers over geotextile fabric and crushed stone for filtration of pollutants beneath parking lots or other infrastructure. Over time, an organic filter cake forms between the chamber and geotextile fabric for enhanced chemical sorption. More research is needed to determine the bacteria removal efficiency.

In this section you will find a list of actions that together become one scenario as to how the county could reach the pollutant load target. While EPS has developed this scenario, progress will be assessed on an annual basis through results of implementation actions and monitoring data. It is intended that the IP will be reviewed on a five-year cycle for potential revisions. The county takes an adaptive management approach to all watershed planning efforts.

Adaptive management is a decision process that promotes flexible decision making that be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood (U.S Department of the Interior 2009). The tools that Baltimore County will use in adaptive management are the tracking of implementation progress through the various actions proposed in the strategy in this section, identification of barriers that prevent targeted actions from occurring, and an enhanced monitoring program to measure progress in both reductions and meeting water quality standards. While this will be an on-going process, there will be a formal review of the strategy at five year intervals to determine if changes are needed or if the strategies are on track.

The actions are broken out into three separate sections. Programmatic actions are actions that do not have a measureable load reduction, but create the condition necessary to reduce the pollutant. Some of these actions require a plan for program development because they are new programs that have not yet been developed by the county. Management actions are actions that require regular actions on county property. Restoration actions are new control measures aimed to reduce pollutant loads. Finally, you can find a discussion of the reductions, which states the year by which the reduction load will be met and describes other factors that play into meeting the water quality criteria.

The actions discussed in this section are to be implemented in addition to currently in-progress or completed programs and restoration actions. Some actions in some parts of Baltimore County have already been completed, such as certain stream restorations, or riparian area reforestations, but there are still many projects in need of completion before water quality goals are met. The Jones Falls watershed is located in parts of Baltimore County and Baltimore City. While the TMDL document requires a reduction for the entire watershed, actions described in this implementation section will be limited to what Baltimore County may oversee, as we cannot direct reduction efforts in other jurisdictions.

Of the 34,122 acre Jones Falls watershed, only 25,933 acres are included within Baltimore County's jurisdiction which is equal to roughly 76% of the watershed. Baltimore County assumes that it is responsible for reducing its *E. coli* load by 12,265.6 billion MPN/year, which is 76% of the 16,139 billion MPN/year that needs reducing for the watershed as a whole. A reduction of 94.9% is necessary for the entire Jones Falls to meet the water quality endpoint of 119.7 MPN/100 ml (5% lower than 126 MPN/ 100 ml to account for margin of safety). Table 9.1 summarizes the reductions needed by station. This section includes many actions that were planned in the SWAP and also discussed in Section 7 of this document.

Table 9.1: Annual Average TMDL and Percent Reduction by Sub-Watershed

Subwatershed	*E. coli* Baseline Load (BillionMPN/year)	Target Load Reduction (BillionMPN/year)	Long-Term Average *E. coli* TMDL Load (BillionMPN/year)	% Required Reduction
JON0184	1,206,325	1,115,075	91,250	**92.4%**
UQQ0005	133,955	123,370	10,585	**92.1%**

JON0082sub	887,315	845,340	41,975	**95.3%**
JON0039sub	3,340,480	1,184,260	156,220	**95.3%**
SRU0005	636,560	622,960	13,870	**97.8%**
Total	**6,204,270**	**5,890,735**	**313,900**	**94.4%**

As discussed in Section 3, it can be seen that high levels of bacteria in the water coincide with high flow rates. This is likely the result of bacteria being washed into the waterways during storm events. High concentrations of bacteria also coincide with warmer times of year. It is expected that human contact will occur most frequently during times of low flow, as storm events (high flow) are not as conducive to water contact recreation. The actions outlined in this section will target reducing bacteria counts during all conditions to acceptable levels. Maryland Department of the Environment – Science Services Administration has indicated that the bacteria reduction targets should be applied to the dry weather flow only, based on the potential for human recreational contact. The final target will be to achieve water quality standards for low flow conditions for annual and seasonal periods, by the end of 20 years of implementation, there will be five year interim goals that will help track progress to the end goal. Table 9.2 shows the interim targets for *E. coli* concentrations when measured both by single samples and by the calculated geometric mean from longer term monitoring. The single sample targets are based on dry weather samples only. Meeting the single sample target means that all dry samples will be less than the level for each of the interim milestones. For example, by 2025 the target is for all dry weather samples to be less than 410 MPN/100 ml. The interim 5-year targets are based on equal progress between the MDE derived low flow seasonal and annual geometric means and the final target of 126 MPN/100mL *E.coli* concentrations. These target apply only to the monitoring sites in the County.

Table 9.2: Five Year Interim Targets for Single Sample and Geometric Mean *E. coli* Densities

Single Sample Target (MPN/100 ml) – All Stations				
Weather Condition	**2020**	**2025**	**2030**	**2035**
Dry	576	410	298	235
JON-3 (JON0184) Geometric Mean Target (MPN/100 ml)				
Low Flow – Annual	222	190	158	126
Low Flow - Seasonal	407	314	220	126
JON-4 (UQQ0005) Geometric Mean Target (MPN/100 ml)				
Low Flow – Annual	300	242	184	126
Low Flow - Seasonal	686	499	313	126
JON-2 (JON082) Geometric Mean Target (MPN/100 ml)				
Low Flow – Annual	NA*	NA*	NA*	126
Low Flow - Seasonal	136	133	129	126

* The annual low flow geometric mean for JON082 is already below 126 MPN/100mL *E. coli*. The monitoring will determine if the station continues below the 126 MPN/100mL standard.

9.1 Action Types

For this IP we will categorize the actions to be taken with respect to addressing source reduction. The actions below are divided into programmatic actions, management actions and restoration actions. Programmatic actions are actions that do not directly result in load reductions, but create the necessary conditions for load reduction. Management actions are those where there is regular management of county property, such as, street sweeping, and sanitary sewer maintenance. Restoration actions include the development of new control measures aimed to reduce pollutant loads as well as retrofits of existing stormwater management facilities. There are many actions that may be taken that would have an explicitly indirect impact on bacteria, however with no ability to prove the cause/effect relationship of these actions, they will be omitted (e.g. stream restorations).

9.1.1 Programmatic Actions

Programmatic actions are those that do not directly result in load reductions, but create the necessary conditions for load reduction. Actions within this category might include public education and outreach activities, monitoring, or supporting specific legislation. These actions will move Baltimore County closer to achieving TMDL targets; however, there is currently no way to attribute a predictable pollutant load reduction to programmatic actions. Some programmatic actions, such as investigation and monitoring, are necessary to implement management and restoration actions or make those actions more efficient. Other programmatic actions, such as education and outreach actions, are predicted to increase the load reduction over time through BMP implementation by individual citizens. The exact load reduction is not predictable because the participation rate for individual home owners installing BMPs, as a result of public education, is not yet known.

9.1.2 Monitoring and Reporting Actions

As a subset of programmatic actions, the monitoring and reporting actions will provide the means for determining progress made in meeting the load reductions. Some of the monitoring actions will be used to better target programs for remediation.

9.1.3 Management Actions

Management actions are those where there is regular management of county property, such as, street sweeping. It does not include the development of new control measures, such as, retrofitting highway yards. Management actions have predictable load reductions, which can be used to calculate the contribution of each action toward meeting the overall load reduction required by the TMDL.

9.1.4 Restoration Actions

Restoration actions include the development of new control measures aimed to reduce pollutant loads as well as retrofits of existing stormwater management facilities. It may include reforestation actions as well as any stormwater control measures that do not require regular management on county property. Restoration actions will have predictable load reductions, which will be used to calculate the contribution of each action toward meeting the overall load reduction required by the TMDL.

9.2 Reductions by Source

The various sources of bacteria will require different management practices to achieve the overall reductions needed to meet bacteria water quality standards. The relative contributions were calculated by MDE for the fours sources; human, domestic pet, livestock, and wildlife. These relative contributions were used to calculate the *E. coli* baseline bacteria loads. Section 3 provides more information on the methods used to determine the relative contribution from sources and the calculation of the baseline loads. The information displayed in Table 9.3 was derived from Table 4.7.1 in the TMDL document.

Table 9.3: Distribution of Sources of *E. coli* Bacteria Loads (MPN/100ml) and % Relative Contribution

Station	Domestic Pet		Human		Livestock		Wildlife		Total Load	% Reduction
	%	Load	%	Load	%	Load	%	Load		
JON0184	27.4%	906.5	52.0%	1,719.2	16.3%	538.1	4.3%	141.5	3,305.3	**92.4%**
UQQ0005	16.8%	61.6	70.5%	258.6	7.4%	27.1	5.3%	19.3	366.6	**92.1%**
JON0082sub	24.1%	585.5	57.8%	1,404.7	13.2%	321.8	4.9%	118.7	2,430.7	**95.3%**
JON0039sub	19.9%	1,816.7	67.5%	6,175.6	9.1%	832.3	3.6%	327.3	9,151.9	**95.3%**
SRU0005	13.8%	240.4	80.1%	1,396.2	5.4%	94.1	0.7%	13.0	1743.7	**97.8%**
Watershed	**16.8%**		**54.6%**		**11.4%**		**3.4%**		**16,998.2**	**94.4%**

*****Percentages by source do not equal 100% because the remainder is from unknown bacteria sources

9.2.1 Reductions to Human Sources

Human sources may be some of the more important bacteria sources to focus on reducing, as human fecal matter is the most probable transporter of human pathogens. Based on annual weighted average measurements in the TMDL document, approximately 54.6% of the Jones Falls inputs are from humans. The Jones Falls is serviced by sewer systems and a small portion by septic systems. Failing septic systems, leaking infrastructure, and Sanitary Sewer Overflows (SSOs) all contribute to human fecal bacteria inputs. SSOs, in the sewered portion of the watershed, are expected to be largely addressed by Baltimore County's continuing compliance with the consent decree to eliminate all SSOs within the County by March 2020. According to MDE, the Most Practicable Reduction (MPR) for reduction of human bacteria inputs is 95%. For all subwatersheds in the Jones Falls, water quality standards could not be met based on MPRs. Fecal bacteria reductions from human sources would need to reach 98% in order to meet water quality standards.

9.2.2 Reductions to Domestic Pet Sources

Based on annual weighted average measurements in the TMDL document, approximately 16.8% of total bacteria inputs to the watershed come from domestic pet sources. A large contributor of the domestic bacteria in Jones Falls comes from pet owners failing to pick up dog waste, and from runoff carrying that dog waste into streams and tributaries. MDE states the maximum possible reduction for this type of bacteria input is 75%. The majority of reductions to domestic bacteria inputs are expected to come from a focus on educational programs to promote behavioral change in pet owners. For all of the Jones Falls subwatersheds, necessary reductions matched the MPR.

9.2.3 Reductions to Livestock Sources

According to the TMDL document, livestock accounted for 11.4% of bacteria inputs to the Jones Falls watershed. MDE states the maximum possible reduction for this type of bacteria input is 75%. For all of the Jones Falls subwatersheds, necessary reductions matched the MPR. Reductions to livestock bacteria inputs can be met using sediment reducing BMPs.

9.2.4 Reductions to Wildlife Sources

Based on annual weighted average measurements in the TMDL document, approximately 3.4% of total bacteria inputs to the watershed come from wildlife sources. They are not subject to laws or property boundaries, and are not suited to educational programs. This makes managing wildlife bacteria inputs quite difficult, and MDE acknowledges that the maximum possible reduction for wildlife bacteria inputs is actually 0.0%.

9.3 Implementation Actions

Table 9.1 below outlines the specific actions intended to be taken to reduce bacteria inputs to Gwynns Falls. These actions are organized by action type, as discussed above, and they indicate which source will be addressed by implementing each action. The table also includes a time frame to indicate a predicted time period by which the action should be fully implemented, and a performance standard to measure success. The column of responsible parties will indicate who will likely be tasked with implementing that specific action.

Table 9.4: Implementation Actions for the Reduction of Bacteria in Jones Falls

Action	Time Frame	Performance Standard	Responsible Party	Source Addressed[1]			
				H	D	W	L
Programmatic Actions							
Develop an agriculture workgroup to address livestock sources of bacteria.	1-20 years	Workgroup established, # of agricultural actions taken to address livestock bacteria	EPS, Agricultural Community				**X**
Continue to meet the requirements of the consent decree for the elimination of sanitary sewer overflows.	Ongoing	Status report	Baltimore County	**X**			
Implement a unified restoration tracking system to track progress toward meeting TMDL reduction requirements.	2 years	None	Implementation Committee	**X**	**X**	**X**	**X**
Support State and County efforts to reduce and eliminate homelessness.	10 years	Actions taken	EPS	**X**			
Implement an awareness campaign to spread information regarding pet waste and streams.	3-20 years	Number of educational activities performed.	EPS, Blue Water Baltimore		**X**		
Measure behavioral change in pet waste management as a result of educational/outreach efforts. Check behavior against state/national averages if data is available.	3-5 years	Report on behavioral change that has resulted from educational/outreach efforts.	EPS		**X**		
Promote PAI's "Rat Attack" program to mitigate rat infestations.	20 years	Measurable reduction in number of rat complaints; measurable reduction in rat sourced bacteria if species tracking is available.	PAI			X	
Assess alternate implementation practices over time as they become known to Baltimore County.	On-going	Take advantage of future advancements in technology and accepted practices that we may not be aware of at the time of producing this document.	All	X	X	X	
Management Actions							

Action	Time Frame	Performance Standard	Responsible Party	Source Addressed[1]			
				H	D	W	L
Street Sweeping Existing.	On-going	Historic Data	Baltimore County EPS		X	X	X
Storm Drain Inlet Cleaning.	On-going	Historic Data	Baltimore County EPS		X	X	X
Restoration Actions							
Implement Consent Decree and Eliminate Sewer Overflows.	6 years (Consent decree is until 2020)	SSOs addressed each year	DPW	X			
Continue to assist land owners in addressing failing septic systems.	On-going	Number of failing septic systems corrected	EPS, GWM	X			
Investigate and convert existing dry detention ponds identified for water quality treatment.	10 years	Acres addressed	Baltimore County EPS		X	X	X
Design and implement stormwater retrofits at all feasible sites.	4 years	Acres addressed	Baltimore County EPS, Blue Water Baltimore		X	X	X
Continue Stream restoration projects.	10 years	Projects completed	Baltimore County EPS	X	X	X	X
Monitoring Actions							
Continue the Bacteria Trend Monitoring Program.	On-going	Annual monitoring at all sites	EPS	X	X	X	X
Implement the Bacteria Subwatershed Prioritization Program.	2-years	Annual Reporting at all sites	EPS	X	X	X	X
Implement the bacteria source tracking monitoring program, in subwatersheds with high bacteria concentrations.	2-20 years	Annual monitoring at all designated sites.	EPS	X	X	X	X
Continue to implement Stream Watch, a citizen-based program, to increase the ability to identify sources of water quality and habitat degradation.	On-going	Number of stream miles adopted in the Baltimore County portion of Lower North Branch of the Patapsco River	Blue Water Baltimore	X	X		
Work with MDE to repeat the bacteria source contribution monitoring, in association with the MS4 Permit renewal for all sites that are not meeting bacteria water quality standards.	5 year intervals	Results at 5-year intervals	EPS, MDE	X	X	X	X

Action	Time Frame	Performance Standard	Responsible Party	Source Addressed[1]			
				H	D	W	L
Work with MDE to investigate feasibility of a method of source tracking that will provide more specific allocations among wildlife species (e.g. DNA testing or other).	2 years	Ability to track wildlife bacteria sources by species.	EPS, MDE			X	
Reporting Actions							
Implementation Committee to meet on a semi-annual basis to discuss implementation progress and assess any changes needed to meet the goals.	20 years	2 meetings per year	EPS and Implementation Committee partners	X	X	X	X
Continue to update status of restoration projects and BMPs in the Annual MS4 Report.	Annually	MS4 Report submitted to MDE and posted on county website	EPS	X	X	X	X
Implement the Continuing Public Outreach Plan.	On-going	Number of actions per year	EPS	X	X	X	X
Hold Biennial State of Our Watersheds Conference in even years.	Biennially	Conference Held	EPS	X	X	X	X
Adaptive Management assessment of the Implementation Plan.	5 year interval	Assessment complete	EPS	X	X	X	X

1. Sources H (Human); D (Domestic Pet); W (Wildlife); L (Livestock)

9.4 Timeframe and Responsible Parties

Baltimore County Department of Environmental Protection and Sustainability (EPS) will partner with other County agencies and with local citizen-based organizations to implement this plan. Dependent on the specific action, different parties may be responsible for implementation. Some actions involve implementing a program, such as tree planting or impervious surface removal, at an institutional site, and that institution will be one of the multiple groups responsible for implementation.

This TMDL Implementation Plan is built using an adaptive management approach. This approach requires periodic assessment of progress and an assessment of changes needed in the Implementation Plan. This periodic assessment will be coordinated with the Municipal Separate Storm Sewer System (MS4) 5-year permit cycle and will take place prior to the re-application process, and will be included as part of the re-application assessment of the success of the management programs.

9.5 Anticipated Pollutant Load Reductions

The available literature supports that the actions above will have a positive effect on bacteria load reduction, however, the exact reductions from implementing those actions is not yet known.

There is no known loading rate of bacteria by land use for Baltimore County and therefore it is not possible to predict reductions from BMPs by drainage acre treated. For this reason, specific acreages and linear feet are not provided in the table above. Baltimore County acknowledges that the priority is to address human sources of bacteria due to greater health risk. The TMDL states that the reduction of human sources has a Maximum Extent Practicable of 95%; however, as previously discussed one subwatershed requires a 98% reduction to achieve water quality standards. The County feels that a goal of 100% efficiency from SSO elimination will be achievable. While Baltimore County expects a 100% reduction in SSO elimination, we cannot account for failures due to mechanical failure, natural disaster, or vandalism, which are issues that may be addressed by an adaptive management solution in the future. Additionally, through data received regarding a point in time survey for homeless people from Baltimore County Department of Planning, the County can determine outdoor public areas where there are no sanitary facilities and can conduct public outreach on the health concerns of bacteria which could prevent bacteria from entering waterways. It is important to note that due to the nature of this watershed, a significant portion of human inputs may be coming from failing septic systems, which are not controlled under the consent decree. BMPs to reduce runoff to water ways and homeowner education on septic system maintenance will be the main actions by which septic based sources are reduced.

9.6 Reductions Discussed

The timeline to implement all of the future actions with measurable reduction extends over the next 20 years. That means that all actions will be implemented by 2035. However, it is important to understand the role of lag times in watershed management and planning. Lag time is the delay from when a pollution control action is taken to when it actually results in water quality improvements. It is the sum of time required for practices to take desired effect, time required for effect to be delivered to the water source, and time required for the waterbody to respond to the effect (Meals, Dressing and Davenport 2010). Lag Times will vary depending on the watershed, the management action and the pollutant type. According to the Chesapeake Bay STAC Program Report from 2012, the lag time for sediment from source to stream in the Chesapeake Bay region is less than 1-5 years, but he lag time for sediment transport from stream to Bay is 5-100 years (Chesapeake Bay Program 2012). There is little data specifically for lag times of bacteria reduction. However, given this data, it is reasonable to assume that in-stream reduction will not necessarily be measurable by 2035 when all actions will be implemented. What this means is that Baltimore County may implement all of the necessary measures to meet the TMDL reductions by 2035, as TMDL is actually a limit on the amount of pollutant that is allowed to enter the stream from upland sources, but measureable in-stream effects on water quality may take a decade or more to fully reflect the load reductions. Expectations for water quality improvement should be reasonably based on the effects of lag time.

Additionally, the distribution of the stations spans Baltimore County and Baltimore City, with stations JON0184, JON0082, and UQQ0005 in the county and stations JON0039 and SRU0005 in the city. While Baltimore County has sole responsibility for achieving the bacteria water quality standards at stations JON0184, JON0082, and UQQ0005; achieving the bacteria water quality standards at the city monitoring stations is dependent on restoration actions implemented by Baltimore City. The modified Trend Monitoring Program will add stations at the city/county line to document the Baltimore County contribution to the downstream monitoring stations and meeting the interim targets and the ultimately all bacteria water quality standards at those sites is part of this implementation plan.

Section 10 – Assessment of Implementation Progress

The assessment of implementation progress is based on two aspects; progress in meeting programmatic, management, and restoration actions; and progress in meeting water quality standards and any interim water quality benchmarks. The assessment of progress in meeting the restoration actions; includes setting up methods of data tracking, validation of projects, and pollutant load reductions associated with the actions (10.1) and will be consistent across all TMDL Implementation Plans. The assessment of progress in meeting water quality standards and interim milestones (10.2) is the data analysis associated with the monitoring plan specific to each TMDL Implementation Plan.

10.1 Implementation Progress: Data Tracking, Validation, Load Reduction Calculation and Reporting

The Baltimore County Department of Environmental Protection and Sustainability – Watershed Management and Monitoring Section is currently preparing a document entitled *Baltimore County Method for Pollutant Load Calculations, Pollutant Load Reduction Calculations, and Impervious Area Treated*. This document will detail the data sources, data analysis (including pollutant load calculations, and pollutant load reductions calculations), validation of the practices, and reporting of progress made. It was determined that a document was needed to document how Baltimore County calculated pollutant loads and pollutant load reductions from the implementation of various best management practices, as guidance from the State continues to evolve. The document also needs modification based on the published literature and to include any additional findings that result from our monitoring programs. The document will be updated annually to account for any changes that may have occurred during the previous year. Due to the fact that implementation is being achieved through the actions of many county agencies, it was also determined that the means of data acquisition, any data manipulation, and the means of data analysis needs to be documented on an annual basis to provide consistency in the data acquisition and analysis and to document any changes in the process over time. The overall result is intended to provide transparency for the general public and users of reports on progress generated as a result of the analysis.

The Maryland Department of the Environment (MDE) has provided a guidance document for NPDES – MS4 permits entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. The draft document was released in June 2011, followed by a final release in August 2014. The document is intended to provide consistency among the MS4 jurisdictions in calculating baselines and reporting implementation progress. This document however, does not provide guidance on bacteria, chlordane, mercury, or PCB reduction efficiencies. MDE also provides guidance through its web site, with a webpage entitled *Maryland TMDL Data Center*. This site provides guidance on the development of the TMDL Implementation Plans and is updated on a regular basis.

The document *Baltimore County Method for Pollutant Load Calculations, Pollutant Load Reduction Calculations, and Impervious Area Treated* will be posted for review and comment in the spring of 2015. It will be modified on an annual basis to take into account any modifications to any guidance documents, monitoring results, and/or new literature; and future calculations will reference the edition on which the calculations were based.

10.1.1 Reporting

Baltimore County will prepare two-year milestones for each local TMDL in conformance with the Chesapeake Bay TMDL two-year milestone process. Programmatic actions and monitoring data analysis will be based on the calendar year, while restoration actions will be based on the fiscal year (July 1 – June 30). The current two-year milestone period was developed in January 2014; for Programmatic actions covers January 2014 through December 2015, and for restoration actions cover July 1, 2013 through June 30, 2015. When the next two-year milestones are developed in 2016, they will be presented by watershed and will include each of the local TMDLs.

Reporting will be done through the annual NPDES – MS4 Permit Report. This is technically due on the anniversary date of the permit renewal, but will be completed for submittal to MDE in October each year. The report will detail progress made in meeting each of the local TMDLs and the Chesapeake Bay TMDL. The analysis will include progress in meeting the two-year milestone programmatic and restoration actions, along with the calculated load reduction. It will also present the results of the monitoring conducted the previous year. See below for TDML specific monitoring.

In January of each year, a progress report (mostly extracted from the MS4 report) will be prepared and posted on the web.

10.2 Implementation Progress: Water Quality Monitoring

The Jones Falls bacteria monitoring will initially focus on two of the three bacteria monitoring programs, trend monitoring and subwatershed prioritization monitoring. The bacteria source tracking monitoring program will be implemented based on the results of the subwatershed prioritization monitoring program. Table 10.1 presents the bacteria monitoring locations, by subwatershed and monitoring type and Figure 10.1 displays the locations.

Table 10.1: Existing and Future Jones Falls Bacteria Monitoring Site Locations and Type

Station Code	Subwatershed	Monitoring Type	Latitude	Longitude
JON-1	Jones Falls mainstem City	Trend	39.327	-76.640
JON-2	Jones Falls below Dam	Trend	39.378	-76.644
JON-3	Jones Falls mainstem above Lake Roland	Trend	39.391	-76.661
JON-4	Roland Run	Trend	39.399	-76.649
JON-5	Stoney Run	Trend	39.326	-76.626
JF-B-1	Towson Run	Subwatershed Prioritization	39.389	-76.641
JF-B-2	Ruxton Run	Subwatershed Prioritization	39.393	-76.642
JF-B-3	Roland Run – West Branch	Subwatershed Prioritization	39.415	-76.646
JF-B-4	Roland Run – East Branch	Subwatershed Prioritization	39.415	-76.645
JF-B-5	Deep Run – Jones Falls	Subwatershed Prioritization	39.417	-76.671
JF-B-6	Jones Falls – Unnamed Trib. 1	Subwatershed Prioritization	39.416	-76.674
JF-B-7	Dipping Pond Run	Subwatershed Prioritization	39.425	-76.689
JF-B-8	North Branch Jones Falls	Subwatershed Prioritization	39.422	-76.710
JF-B-8	Jones Falls – Headwaters	Subwatershed Prioritization	39.410	-76.719
JF-B-10	Slaughterhouse Branch	Subwatershed Prioritization	39.399	-76.668
JF-B-11	Moores Branch	Subwatershed Prioritization	39.394	-76.670
JF-B-12	Western Run – East Branch	New Trend	39.373	-76.668
JF-B-13	Western Run – West Branch	New Trend	39.372	-76.708
JF-B-14	Dipping Pond Run – East Branch	Subwatershed Prioritization	39.419	-76.670

10.2.1 Bacteria Trend Monitoring Program

The Bacteria Trend Monitoring has been implemented in conjunction with Baltimore City since June 2010 and consists of five monitoring sites within the Jones Falls watershed, which MDE used in developing the Jones Falls Bacteria TMDL. The program is designed to determine bacteria concentration trends over time and whether the sites are improving, degrading or meeting water quality standards. Monitoring at these four sites will continue until bacteria water quality standards are met at all sites. Two new trend sites will be added to this bacteria monitoring program both on Western Run – Jones Falls, one on the West Branch and one on the East Branch. These new trend sites are located on the city/county line and will be used to document bacteria concentrations as the streams discharge from the county into the city. They will also, along with three existing trend sites located in Baltimore County (JON-2, JON-3 and JON-4) serve to document improvement in bacteria concentrations as a result of restoration efforts by the county.

10.2.2 Subwatershed Prioritization Bacteria Monitoring Program

The subwatershed prioritization bacteria monitoring program is designed to provide more detailed information on bacteria on a subwatershed basis. The sites used by MDE to develop the Jones Falls TMDL do not provide sufficient information on the bacteria concentrations in the subwatersheds within the Jones Falls. In order to focus bacteria reduction efforts, 12 subwatersheds will be monitored on a fixed site, fixed interval basis over the seasonal monitoring period (May 1st through September 30th) for two successive years starting in 2015. Based on the data from the first year, subwatersheds with higher bacteria concentrations will be selected for bacteria source tracking monitoring. The second year of subwatershed prioritization will serve as confirmation of the subwatersheds with higher bacteria concentrations.

10.2.3 Bacteria Source Tracking

The bacteria source tracking program is designed to locate sources of bacterial contamination by monitoring stream reaches in tributaries identified as having high bacteria concentrations. This monitoring program has not been initiated within the Jones Falls. Bacteria source tracking monitoring sites will be added, based on the results of the subwatershed prioritization bacteria monitoring. Subwatersheds with high bacteria concentrations will be selected for bacteria source tracking monitoring.

10.2.4 Bacteria Source Relative Contribution Monitoring

In the development of the Jones Falls Bacteria TMDL, MDE used a methodology to identify bacteria sources in four categories, human, pet waste, livestock, and wildlife; and the relative contribution of each to the bacteria load. As progress is made in reducing the bacteria concentration, it is expected that the relative contribution from the various source categories will change. Since it is important to know the relative contribution from the various sources in order to target remediation actions correctly, Baltimore County will work with MDE to develop a program whereby at the beginning of each 5-year MS4 Permit cycle, the Bacteria Source Monitoring will be repeated for those Bacteria Trend Monitoring sites that are not meeting bacteria water quality standards.

For those sites that require a wildlife bacteria reduction to meet the bacteria water quality standards, Baltimore County will work with MDE to determine how to refine the wildlife source to species if possible. The results will determine if an existing program can be enhanced (rat control and deer control programs), if another program needs to be developed, or whether the wildlife sources are such that we will need a greater period of time to meet the bacteria standard, and if it is possible to meet the standard.

Figure 10.1: Map of Jones Falls Monitoring Locations by Monitoring Type

In order to engage the public in the TMDL implementation process this continuing public outreach plan will be implemented upon approval of this TMDL Implementation Plan. The continuing public outreach plan is applicable to all TMDL Implementation Plans that are currently being developed and those developed in the future, as well as the Trash and Litter Reduction Strategy. This continuing public outreach plan is meant to engage county agencies, environmental groups, the business community, and the general public.

11.1 County Agencies

County agencies will be engaged through two regularly scheduled NPDES Management Committee meetings per year and other agencies meetings as necessary to move implementation forward.

11.1.1 NPDES Management Committee

The NPDES Management Committee is composed of representative agencies that are involved in meeting the NPDES – MS4 Permit requirements. This committee has met irregularly in the past, generally to review information on permit requirements and other upcoming regulatory requirements, such as, the General Industrial Stormwater Discharge Permit. In the future this committee will meet twice per year and will discuss not only the NPDES – MS4 Permit requirements, but also the TMDL Implementation Plans and progress being made in meeting the implementation strategy. In order to address all components of the TMDL Implementation Plans the committee membership will be expanded to include any county agency that has some responsibility for TMDL implementation. Examples being, the County Police Department and the Department of Environmental Protection and Sustainability – Groundwater Management Section. Prior to the development of the TMDL Implementation Plans and the Trash and Litter Reduction Strategy, these agencies were not specifically engaged in NPDES – MS4 Permit activities.

The first yearly meeting will be held in January of each year. The focus of this meeting will be to review the implementation plan 2-year milestones for each plan; provide a forum for discussion of the ability to meet the implementation actions; and determine any revisions necessary to meet the interim implementation milestones set in the plan. This meeting is also the forum for discussion of data tracking and reporting to ensure that the implementation actions are properly credited.

The second yearly meeting will be held in July of each year and will provide the forum for determining data submittal for the yearly progress report on the implementation actions and the resulting load reductions. The monitoring data from the previous calendar year will be presented and contrasted with the interim water quality milestones that are detailed in each implementation plan.

11.1.2 Other Agency Meetings

In order to move forward with implementation, agency meetings regarding specific implementation actions are anticipated. These will be scheduled as needed, and tracked by meeting date, attendance, TMDL Implementation Plans discussed, and topic. Meeting minutes will be reported in the Annual NPDES – MS4 Report submitted to Maryland Department of the Environment. This report is also posted on the county website for public access.

11.2 Environmental Groups

Baltimore County is currently engaged with local watershed associations through its funding of *Watershed Association Restoration Planning and Implementation Grants*, and through inclusion of watershed association members on the Steering Committees of the Small Watershed Action Plans. Formerly, this engagement and support was coordinated through the *Baltimore Watershed Agreement*. As part of that engagement, periodic Watershed Advisory Group (WAG) meetings were held. As part of this continuing public outreach plan, WAG participation will be formalized with two meetings per year.

The first meeting will be held in March of each year and focus on the local and Chesapeake Bay TMDL implementation actions and implementation progress, including an analysis of the pollutant load reduction calculations from the previous fiscal year. The watershed associations are currently engaged in citizen-based restoration activities and report their implementation progress to the county for inclusion in the Annual NPDES – MS4 Report. This meeting will provide a forum for discussion of the progress being made, coordination between the watershed associations, and any changes to the *Watershed Association Restoration Planning and Implementation Grant* being considered for the next grant period.

The second meeting will be held in November of each year and will focus on the water quality monitoring results from the previous calendar year. The results presented will compare trends and measures against the TMDL Implementation Plans water quality benchmarks and water quality standards.

11.3 Business Community

The business community will be engaged through various business forums, targeted outreach and education efforts on specific topics, and hosting workshops on specific topics as necessary.

11.3.1 Business Forums

Business forums, such as the Hunt Valley Business Forum with greater than 200 business members, provide opportunities to present the TMDL Implementation Plans and the Trash and Litter Reduction Strategy, and discuss the role of business in helping improve water quality. These forums will be convened as the opportunities arise. Summaries of these meetings will be reported in the annual NPDES – MS4 Report and will include the name of the forum (or other business organization), approximate number in attendance, the topic presented, and audience responses.

11.3.2 Targeted Business Outreach and Education

The Small Watershed Action Plan (SWAP) process includes an upland assessment of potential pollution hotspots. Often, these potential hotspots are commercial or industrial sites. The information derived from this assessment will be used to target outreach and education to businesses specific to the issue(s) at the location identified in each SWAP. These actions will be tracked and reported in the annual NPDES – MS4 Report.

11.3.3 Business Workshops

There are certain issues that may be pervasive through a segment of the business community that can most effectively be addressed through hosting workshop education on the specific topic. These issues will be identified as SWAP implementation moves forward, but one potential topic for a business workshop is related to the recently renewed *General Discharge Permit for Stormwater Associated with Industrial Activities.* A workshop designed in conjunction with Maryland Department of the Environment would not only result in improved water quality, but it would also benefit the business community through increased understanding of the requirements of the permit.

11.4 General Public

The general public will be engaged through a number of mechanisms, including:

- Watershed Implementation Plan (WIP) team meetings
- Targeted outreach and education efforts on specific topics
- Steering committee meetings and stakeholder meetings in the development of Small Watershed Action Plans
- Meetings of the implementation committee for completed Small Watershed Action Plans
- Displays at various events
- Annual progress reports posted on the county website and placed in our libraries
- A biennial *State of Our Watersheds* conference.

11.4.1 WIP Team Meetings

Baltimore County has assembled a WIP team to serve as a sounding board for the development of the WIP to address the Chesapeake Bay TMDL. Members of the team include representatives from various county agencies, business community representatives (particularly the environmental engineering community), watershed associations, representatives from the agricultural community, and Baltimore County citizens.

The county will schedule at least one meeting annually to present implementation progress and to address specific topics related to the TMDL Implementation Plans and the Trash and Litter Reduction Strategy. Meetings will be scheduled as issues arise. It is anticipated that the WIP team will provide initial review of newly developed outreach and education materials, in order to provide feedback from a variety of perspectives.

11.4.2 Targeted Outreach and Education

The Small Watershed Action Plan development process includes upland assessments of neighborhoods to identify pollution sources and restoration opportunities. This information will be used to prioritize and target outreach and education efforts specific to the issue(s) in neighborhoods with the intent to affect behavioral change and/or increase citizen based restoration actions. These actions will be tracked and reported in the annual NPDES – MS4 Report.

11.4.3 SWAPS

Baltimore County has been developing SWAPs since 2008. There are 22 planning areas in the county, with 13 completed plans, 5 plans in development, and 4 areas pending. These planning areas cover the entire county. The planning process includes the development of a steering committee, the composition of which is determined by the issues, and land ownership within the planning area. At a minimum membership consists of agency representatives, watershed associations, and citizen representatives. The process also includes a number of stakeholder meetings, open to all planning area residents and businesses, which provide information on the plan and solicit input. Once the SWAP is complete, the steering committee becomes the implementation committee. As designed, the implementation committee is to meet twice per year, however, most implementation committees have not met this goal.

The plans have addressed to varying degrees the TMDLs that are applicable within the planning area. Some of the TMDLs have been developed subsequent to the specific SWAP development or did not address the full range of TMDLs that were applicable to the planning area. The TMDL Implementation Plans are built on incorporation of the actions from each SWAP within the applicable TMDL area. In some cases, additional actions have been identified in order to meet water quality standards.

11.4.3.1 Small Watershed Action Plans in Development and Future Plans

For SWAPs currently under development, and for plans developed in the future, the steering committee and stakeholder meetings will be used for outreach regarding the TMDL Implementation Plans and the progress being made in achieving water quality standards. The meeting participants will be informed on where they can access the TMDL Implementation Plans, the Trash and Litter Reduction Strategy and any Progress Reports that have been developed.

Applicable TMDL Implementation Plan actions will be incorporated into the SWAP based on the assessment of applicable restoration actions within the SWAP planning area. Since the SWAPs incorporate field assessments of streams and uplands, they provide more detailed information on applicable restoration actions, both on quantity and location. The accelerated schedule for developing TMDL Implementation Plans precluded conducting field work to build the plans.

11.4.3.2 Small Watershed Action Plans Already Developed

For those SWAPs already developed, the implementation committee meetings will be scheduled twice per year. The first meeting will be held in winter and will present the implementation progress not only of the SWAP, but also any applicable TMDL Implementation Plan progress. The progress analysis will be based on fiscal year. This meeting will also provide the opportunity to discuss any changes in the SWAP or the TMDL Implementation Plan based on an analysis of what actions have been successful and what actions have been more difficult to implement.

The second implementation committee meeting will be held in fall of each year and will present the monitoring data in relation to progress being made toward interim milestones and water quality standards.

11.4.4 Educational Displays at Events

Educational displays and handouts will continue to be used at applicable events as they occur. The particular display and handout materials will be determined by the location and focus of the event. The location, event type, number of citizens engaging staff at the display, and the number of handouts taken by citizens will be tracked for annual reporting in the NPDES – MS4 Report.

11.4.5 TMDL Implementation Plan, Trash and Litter Reduction Strategy, and Progress Report Availability

The TMDL Implementation Plans and the Trash and Litter Reduction Strategy will be posted on the Baltimore County website with hard copies placed in county libraries. The hard copies in the libraries will be specific to the watershed in which the library is located. Progress reports will be posted on the county website and placed in libraries. A set of hard copy plans will be kept at the Baltimore County Department of Environmental Protection and Sustainability office in Towson, Maryland.

11.4.6 Biennial State of Our Watersheds Conference

Baltimore County, in conjunction with Baltimore City, has held *State of Our Watershed* conferences in the past to present information to county and city citizens on water quality issues applicable to the watersheds in these jurisdictions. Future conferences will be held in March of even numbered years. Information on implementation progress for local TMDLs and the Bay TMDL will be presented, along with other topics of interest. These conferences will be organized with the assistance of the WAG, and the surrounding local jurisdictions (Baltimore City, Howard County, Carroll County, Harford County, and York County, PA) will be invited to participate in the organization and presentation of the conference.

The timing of even years is related to the 2-year milestone process set up by the Maryland Chesapeake Bay TMDL WIP whereby in January of even calendar years, progress in meeting the previous 2-year milestone programmatic and restoration implementation is reported and the next 2-year programmatic and restoration implementation milestones are proposed by the local jurisdictions. The timing of the conference not only permits reporting on the progress made in meeting the previous 2-year milestones but also what is planned for the next two years.

11.5 Summary of Continuing Public Outreach Plan

A summary of the continuing public outreach plan, by component, element and frequency is presented in Table 11.1.

Table 11.1: Continuing Public Outreach Plan Summary

Plan Component	Plan Element	Frequency
Agencies	NPDES Management Committee	2x per year
	Other agency meetings	As needed
Environmental Groups	Watershed Advisory Group (WAG) meetings	2x per year
Business Community	Business forums	As identified
	Targeted business outreach and education	As identified
	Topical workshops	As identified
General Public	WIP team meetings	1x per year
	Targeted outreach and education	As identified
	SWAP – steering committee meetings	6x per year, each
	SWAP – stakeholder meetings	2x per year, each
	SWAP – implementation committee meetings	2x per year, each
	Educational displays at events	As identified
	Document availability (various)	As needed
	Biennial conference	Even # years

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